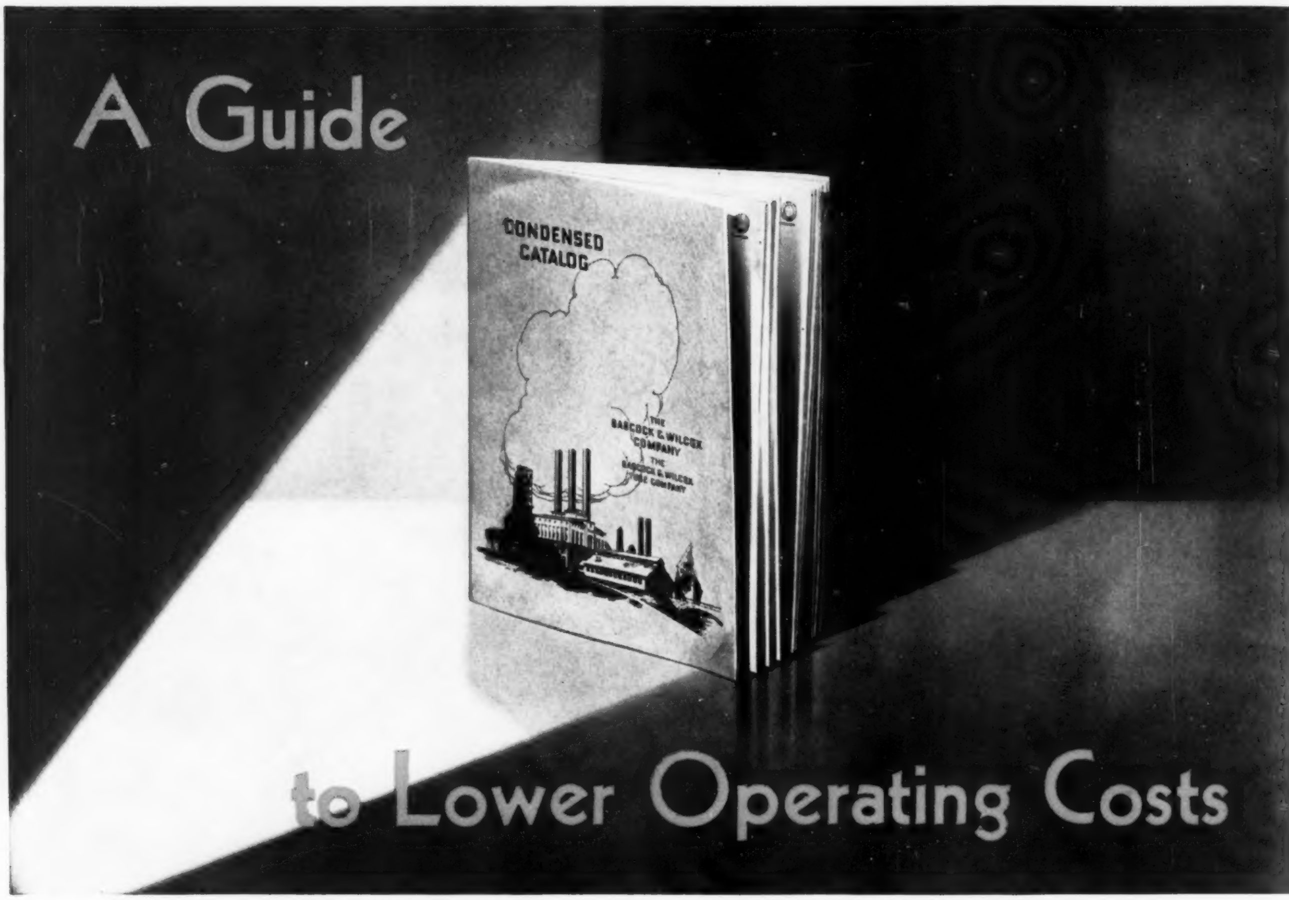
MECHANICAL ENGINEERING

November 1932



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PREPARING FOR A NEW DAY

HOPE, long deferred, that the trend of economic events may be turning upward, is slowly replacing the dark pessimism of the past year. Like mariners who sense the abatement of a storm that has nearly wrecked their vessel, we are ready to direct our attention toward recovery. There were those who lay frightened below, those who in despair counseled abandonment of the ship, and those who murmured mutinously; there were the shrewd and experienced sailors with eyes fixed on sail, wave, and barometer, whose steady hands held the wheel; and there was a brood of land-wise philosophers in the smoking salon who developed theories and critiques of seamanship. To all of these the abatement of the storm's fury has brought new hope, and out of the confusion and damage wrought by the destructive energy of the elements, all are preparing for a new day.

What will the new day reveal? Fundamental weaknesses in the structure of the ship itself which call for change and repair; some of the superfluous cargo, jettisoned during the height of the storm, gone forever; some of the superstructure washed away; a crew and passenger list depleted by drownings, weakened by exposure, incapacitated by illness and accident, sobered by terrifying experiences, and invigorated by restored hope; a humbler but more practical knowledge of seamanship; a determination for wiser conduct, greater control, and more adequate security in the next storm.

IN CASTING about for a peg on which to hang the interests of mechanical engineers in preparing for a new day, it seemed an appropriate truism that mechanical engineering ultimately involves the consumer. The man who buys what is produced by the plants and machinery manned and served, directly or indirectly, by mechanical engineers, utilizes the medium of national currency to exchange the products of his industry, whatever they may be, for those of other men, through the numerous and devious channels of commerce. Hence our cover picture, which, it is suspected, may have been a shock to many a person who thinks of mechanical engineering in terms of machines rather than of the users of machine-made products, indicates that the final (or is it the initial?) step in the cycle of events that keep the wheels of industry turning is the purchase of goods.

PEOPLE buy when they have money—they have money when wages are paid—wages are paid when workers can be employed—workers are employed when goods are being produced—goods are produced when business is good—business is good when people buy. It's not quite as simple as that, but a reasonable resumption of this sketchily generalized cycle, at present well-nigh halted, is the immediate concern of every individual. The economic forces of consumption, production, and distribution are badly out of balance. Perfect balance may never be attained—it may not even be desirable, but gross unbalance is decidedly undesirable. To understand the reasons for unbalance, and with this understanding to take the necessary measures for an improvement in the material well-being of a majority of our people and their social institutions, are essential in preparing for a new day.

TO SURPASS what was thought to be the prosperity of the "new economic era," without its disastrous aftermath out of which we are now floundering, calls for intelligent action by all individuals, groups, and governments. All can help, and rapid recovery depends on properly coordinated efforts. Readers of MECHANICAL ENGINEERING have already had an opportunity to peruse the many discussions published in its pages on the economic ills that beset us and the causes out of which they came. An especially illuminating analysis was published in the June issue in the form of a report on "The Balancing of Economic Forces" by a committee of the American Engineering Council.

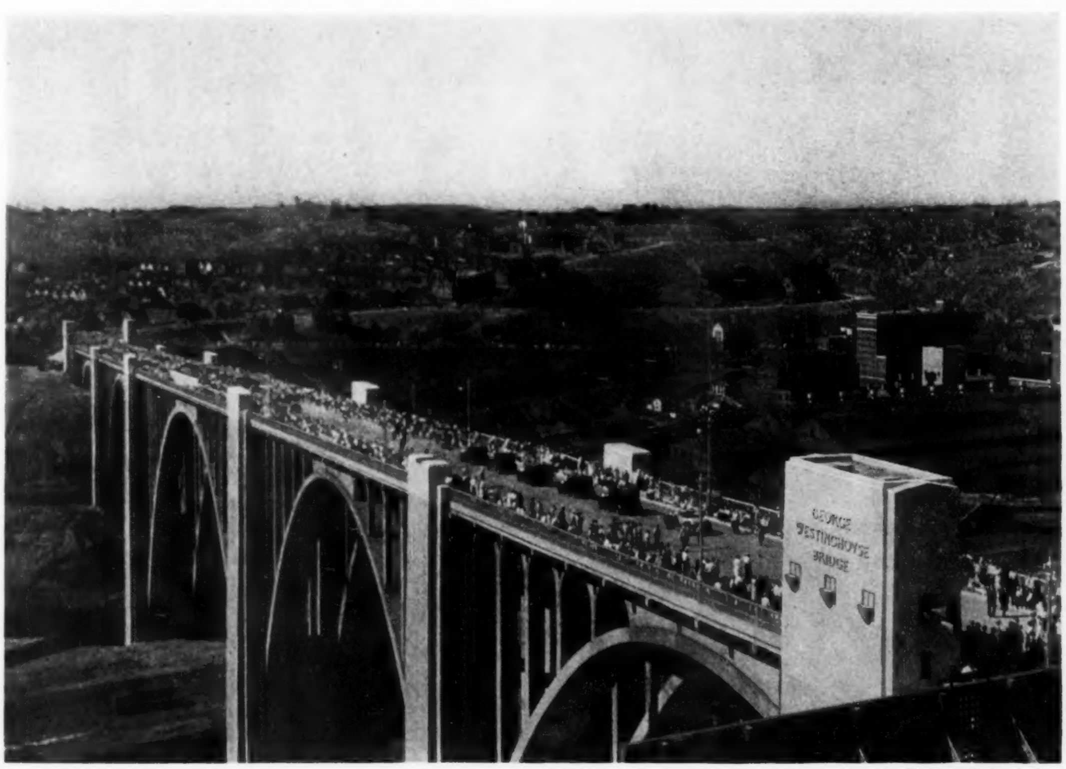
Individuals may now study with profit to the organizations by whom they are employed the papers by Bigelow and Rautenstrauch printed elsewhere in this issue. They may also heed the advice that Dr. Harvey N. Davis gave to the graduating class at Haverford and which was published in the October issue of MECHANICAL ENGINEERING, and inform themselves on fundamental economic principles. They then will have a basis for sober consideration of such points of view as are brought out in Ralph E. Flanders' discussion of two recent books by engineer-economists, and by George L. Hoxie in his paper on the vexing problem of public works, also to be found in the present issue.

THE efforts of special groups and of the Government are day by day becoming more specific. In this month's editorial pages will be found a plea for engineers to assist in the intelligent operation of the Reconstruction Finance Corporation's attempts to stimulate recovery and employment by making loans for self-liquidating public works. Encouragement and also commendation are to be given for effective service rendered to industry and business, and ultimately to individuals, by the six committees of industrialists appointed following a conference with President Hoover. Of these committees, engineers will be chiefly interested in that on increased employment on railroads through expansion of equipment and maintenance programs, and that on expansion

of capital expenditures by industries in the way of replacement of obsolete and worn-out equipment, better known as the Robertson committee. In the success of the work of these committees mechanical engineers in particular are likely to profit directly. Of equal interest, if of less direct benefit to mechanical engineers as a class, are those on making credit useful to business, on increased employment through shortening working hours, on stimulating of repairs and improvement of homes, and on assistance of home owners with maturing mortgages through committees in the several Home Loan Bank districts.

PITFALLS lie in the paths of those who will prepare for a new day, and problems will confront them at every turn. It is not encouraging to realize that those pitfalls and problems are, in many cases, the same that have brought disaster in the past on the one hand, and are still unsolved on the other. To them others will be added, unknown as yet. But the chances of evading the pitfalls and of solving the problems grow as education and technology advance. There are an increasing number of persons of trained intelligence to deal with these matters, and there are an increasing number of powerful elements of progress within the control of engineers and others. Some illustrations scattered throughout the pages that follow call attention to a few of these pitfalls and problems, and to a few of the aids we shall have in dealing with them. They are offered for thoughtful consideration.

ACROSS the valley in which are located the great works founded by George Westinghouse, a new bridge, named in his honor, has recently been opened. It is symbolic of him in that it facilitates the progress of men and provides for their safety, for these were the achievements of the great inventor. The air brake, the railway signal, alternating-current machinery, steel cars for subway operation, and hundreds of other devices were conceived in the brain of this man and provided the basis for new industries. Fertile inventiveness adds to the world's wealth and happiness. Tireless industry in the development of new means of facilitating progress and providing for the satisfaction of human wants, yet unknown, is the very practical procedure that those who prepare for a new day will follow. Men of the stamp of George Westinghouse are sorely needed. They leave a variety of monuments behind them, but the most enduring is the opportunity their genius provides for other men to cultivate and enjoy life.



Keystone-Underwood

GEORGE WESTINGHOUSE BRIDGE

Ewing Galloway, N. Y.

The Producer Is the Consumer

(When men return to their jobs again, the cycle of production, distribution, and consumption will gather headway. The task of today is the return to the job—the task of the future, to control the forces of the economic cycle.)

MANAGEMENT ESSENTIALS *for* RECOVERY

By CARLE M. BIGELOW[1]

LAYING aside all the reasons why, or responsibilities for, the disturbed economic conditions of the last three years, the outstanding characteristic of the depression has been the maladjustment between production and consumption. While we naturally are primarily concerned with the steps management must take to produce a recovery in economic balance and prosperity, as engineers we are also concerned in management's taking every possible step to avoid a repetition of present conditions. After careful consideration it appears that those steps which are essential to recovery, if borne in mind and continued in a period of prosperity, will to a considerable degree prevent a repetition of the experiences of the last three years. Great issues usually find their solution in simple fundamentals. In the preparation of this paper nearly 2600 case reports of professional contacts have been studied carefully as a basis for the conclusions.

The management procedure required to bring about a general recovery of sound business conditions is as follows:

a **Determine product characteristics from the consumer's viewpoint.**

b **Determine the minimum volume that can be absorbed by economic distribution efforts.**

c **Organize the production facilities to produce this volume.**

d **Consider this minimum volume as normal and meet increased demands by overtime or additional regular hours of labor.**

e **Measure all efforts of personnel and compensate them in terms of their contribution to the ultimate profitableness of the business.**

f **Put aside for all time the "volume complex."**

g **Consider just as essential as insurance:**

Maintenance of employment

Building up strong cash reserves

Adequate research.

h **Develop a spirit of cooperation within each industry rather than competition.**

CONSUMPTION FLUCTUATES FAR LESS THAN PRODUCTION

In examining the fluctuations of consumption and production it is evident that, evaluating these fluctuations in terms of fabricated products, which are consumed by the ultimate consumer, consumption fluctuates far less than does production. This is obvious, inasmuch as production periodically has produced goods in excess of consumption, thus building up stocks which enable consumption to be carried on while production is retarded seriously or is practically at a standstill. The result of such a condition is that, due to the failure of production to provide salaries and wages, consumption itself is reduced. It appears, therefore, that if production is attuned properly to consumption, the fluctuations of consumption will be relatively limited, and accordingly our problem for both the present and future is to balance production against consumption.

Furthermore it is practically impossible to control consumption except through the stimulation of promotional efforts such as overextension of credit, forced advance buying, and other mechanisms, the results of which are that any increase in consumption due to their employment is bound ultimately to bring about a balancing effect of restricted consumption. Production, however, can be controlled if industries adopt a common or social viewpoint regarding the volume which they should produce to meet consumption.

However, this involves a fundamental change in management viewpoint. The history of the development of the factory system shows clearly that the underlying policy of business has been to create a product, manufacture it, and then sell or distribute it. Due to the long period of general growth of our country, the development of natural resources, opening up of new territory, and raising to a higher plane of living not only our relatively native population, but particularly the vast number of immigrants coming to us from countries maintaining a much lower standard of living, it has been possible to distribute ever-increasing volumes of goods. However, we have gradually approached a state of relative saturation, as public land has decreased, resources have become more fully developed, and immigration has been restricted. And from now on we must

[1] President, Bigelow, Kent, Willard & Co., Inc., Boston, Mass. Mem. A.S.M.E.

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NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors, and not those of the Society.

reverse our basic philosophy of ***producing and then selling*** to one of *selling and then producing*, in accordance with this ability to sell. A simple philosophy to state, but a tremendously difficult one to put in practice.

At the inception of a manufacturing business there has of course been a consciousness of consumption demand and of a business created to satisfy such a demand. Inevitably, however, in the majority of concerns the tendency has been to assume that since a plant has been built and equipped to produce certain products, sales must dispose of the products of the plant. Under present conditions and in the future, a much sounder philosophy of business is that a concern must determine what it can dispose of at an economic distribution cost, and then adapt the plant to produce this volume of required specified goods at a competitive cost.

If some way can be found to infiltrate this fundamental philosophy throughout American industry, overproduction will virtually become impossible. It will eliminate for all time the "volume complex," because of which organizations have created vast plants of expensive equipment with a view to producing products at lower prices than their competitors. When an entire industry has indulged in such a procedure, the result has been an inevitable overproduction of their products which sales could dispose of only by unsound stimulation methods of promotion and overexpansion of credit, and this has inevitably flooded the market and produced periods of underconsumption when of necessity production virtually has had to cease.

Such a policy will have a tremendous effect upon management, particularly as regards the production phase. Instead of endeavoring to build as large plants as possible, management must endeavor to keep physical facilities as low as possible and still fill the demands of sales. The majority of plants are built to produce maximum demand with one operation shift. It is far better for a plant to operate regularly part or all of its plant on two shifts a day than to produce the same volume with one shift. Plant facilities should be arbitrarily restricted so that one full shift will produce the probable minimum demand of sales. This will call for great flexibility in production control so that it will function effectively in varying periods of one shift, one shift plus overtime, two shifts, or three shifts. In the past, normal daytime plant capacity has generally been considered as the maximum sales volume. In the future, normal plant capacity must be considered as the minimum sales volume.

CHANGE IN POLICY REGARDING MATERIAL CONTROL DURING THE LAST FEW YEARS

In the matter of material control, because of the fact that scientific management was developed largely during a period of increasing commodity prices, the underlying policy has been to always have enough material available. During the last few years of falling commodity prices, we have seen this changed to a policy of carrying the absolute minimum of materials necessary. This is a healthy control, inasmuch as it balances material consumption more closely with ultimate consumption and prevents periodic overproduction and underproduction of raw materials.

In the matter of equipment, there is a pronounced trend toward the greater use of general-purpose rather than special-purpose machinery and tools. When production more or less arbitrarily decided as to what should be made and how much should be made, plants could seemingly be best equipped with special-purpose equipment. In many cases, however, as product changes were required by sheer necessity of meeting consumption demand, such special-purpose machinery had to be junked before its cost had been amortized. With types of products and volume determined more from the sales or consumption viewpoint, it is obvious that plants must be more flexible in order that they may not only be in a position to change types of product frequently, but to avoid unabsorbed amortization of special-purpose equipment.

DEVELOPMENT OF A TECHNIQUE OF DISTRIBUTION NECESSARY

In the field of general management more attention has been paid to the development and management of the production phase of business than to the sales or distribution phase. From now on, technical ability must be directed primarily to the distribution phase. A technique of distribution similar to that developed for production is essential. However, it must be borne in mind that in the development of the technique of distribution, production must not be lost sight of as has so generally the sales viewpoint been given insufficient consideration in the development of the technique of production. The technique of distribution must be developed carefully along the four following major classifications:

1 Selection of products and their characteristics in terms of consumer requirements
2 Selection and evaluation of markets in terms of consumer requirements and economic cost of distribution
3 Precise planning of selling effort, with strict coordination with the promotion phase
4 Scientific compensation of all sales personnel.

It is not the purpose of this paper to discuss the lines along which this development should be conducted, except to point out that in the development of sales technique the evaluation of effort must be translated into the effect on profitableness rather than into terms of sales volume. For instance, the compensation of salesmen in terms of volume sold is fallacious where profitableness varies between different classes of goods sold.

NEW VIEWPOINT ON GENERAL ADMINISTRATION POLICIES ESSENTIAL

In approaching the general administration policies of industry, an entirely new viewpoint is also essential. While there are the three distinct phases of production, distribution, and control in any business, the evaluation and control of any problem which arises, either tem-

porary or permanent, must be decided in terms of its joint effect upon the three phases of business coordinated into its effect upon the profitableness of the business as a whole. Every phase and mechanism must be subjected to the most rigid scrutiny and evaluated solely in terms of its ultimate effect upon this overall profitableness. Fortunes have been lost in the past in increasing the effectiveness of production which could only be translated into ultimate possibility by the consummation of a sales volume obtained at such an uneconomic selling expense that the economies in production were ultimately lost in the resulting extravagance in distribution.

All control and accounting records must be so set up that the effect of each function upon ultimate profitableness is clearly revealed. In connection with the maintenance of statistics and control records, great economies are possible and essential. Methods and records are merely tools of management. When a business has been established and operated for a considerable period of time with complete records, management develops an intuition that makes the continued use of complete detailed records unnecessary. When this degree of judgment has been developed in management, many detailed records can be temporarily abandoned. Periodically, however, they should be reestablished in order to create a closer control and redevelop the judgment of management. In the majority of cases, however, it is not essential that complete control records be maintained constantly, nor can business afford to absorb their cost. There naturally will be periods of relatively greater and less consumption and production. The cost of control records can be absorbed more economically during the periods of heavy production. If management is effectual, they can be abandoned to a considerable extent in periods of lower production. Methods and records have gradually been developed to the point where often they are maintained as an end in themselves.

RECORDS USELESS EXCEPT AS MANAGEMENT TRANSLATES THEM INTO ACTION

Fundamentally, records and methods are useless except as management translates them into action. Management can only maintain a high degree of effectiveness by periodically reducing the employment of methods and records. This is a most heretical statement for a management engineer to make, but it is becoming more and more apparent that the essence of sound management is the development of effective personnel, with a minimum of methods and records, rather than mediocre personnel with a plethora of records and methods. In the field of art, the great masters always have been distinguished by their simplicity. Only the tyro indulges in multiplicity of detail. So in developing the management of the future, methods and records must be maintained at an absolute minimum, and the personal ability of management capitalized and increased. The production phase of management has been overmechanized and overstandardized. As major endeavors extend more and more into the field of distribution and the general administrative phases of business, a repetition of this mistake must be avoided. Much has been said of the "one best way." It is true that there is a "one best way" for each individual organization, but very rarely is this "one best way" the same for two concerns, nor does it remain constant within one concern. Two businesses which have passed through the depression excellently make a very similar product and have about the same sales volume. Their profitableness is practically identical. One management uses an immense number of methods and records; the other uses practically none. Each is right. The one management would be lost without its involved control; the other would be helpless with it.

Inasmuch as it is necessary for production to be maintained so that consumption will not be impaired, the selection of the proper minimum activities for a company is most essential. A company will make a far better contribution to the welfare of society as a whole by maintaining a steady production of a minimum volume than by building up such an excess production that it is periodically forced to subnormal volumes. Incidentally, more total employment will be provided. Operating at a steady, reasonable volume provides a far better insurance to employment than any of the many financial-reserve plans which have been suggested to meet subnormal periods. If we avoid the subnormal periods, we shall not have to provide for them.

Business must also maintain its dividend payments at figures giving a fair return on capital invested, rather than pay high dividends during periods of relatively high production, with resultant depletion of surpluses and reserves during low periods, followed by non-payment of dividends. We have overemphasized the factor of inactive capital in a great many cases. Heavy cash reserves will be more essential in the future to meet the changing requirements of consumption demand.

Management itself should be paid in proportion to results attained. These results should always be evaluated in terms of contribution to the profitableness of the business as measured within the limits under the control of each individual.

One of the most unfortunate proclivities of business is that of utilizing research to an adequate degree in periods of high production and, in the majority of cases, abandoning it during low periods. Every business, no matter how small or large, should have a definite, continuous program of both sales and technical research. This is as necessary as fire insurance. Certain products must be developed in advance of the general market, to maintain a satisfactory sales position.

It is obvious that it is difficult for an individual concern to establish its policies as to volume without consideration of the other competitive units of the same industry. It is becoming increasingly evident that "competition is *not* the life of trade," and that co-operation between the various units of an industry is essential. While our anti-trust laws render this somewhat difficult, standardized trade practice generally is being infiltrated into many of our industries with satis-

factory results. The great evil of inadequate pricing of goods, with resultant loss of profit margins due to competition, can be offset only by the establishment of proper cooperative relationships in each industry. This is most essential to the establishment and maintenance of the policies recommended herein.

DESIDERATA FOR RECOVERY

To summarize, the management procedure required to bring about a general recovery of sound business conditions is as follows:

a Determine product characteristics from the consumer's viewpoint

b Determine the minimum volume that can be absorbed by economic distribution efforts

c Organize the production facilities to produce this volume

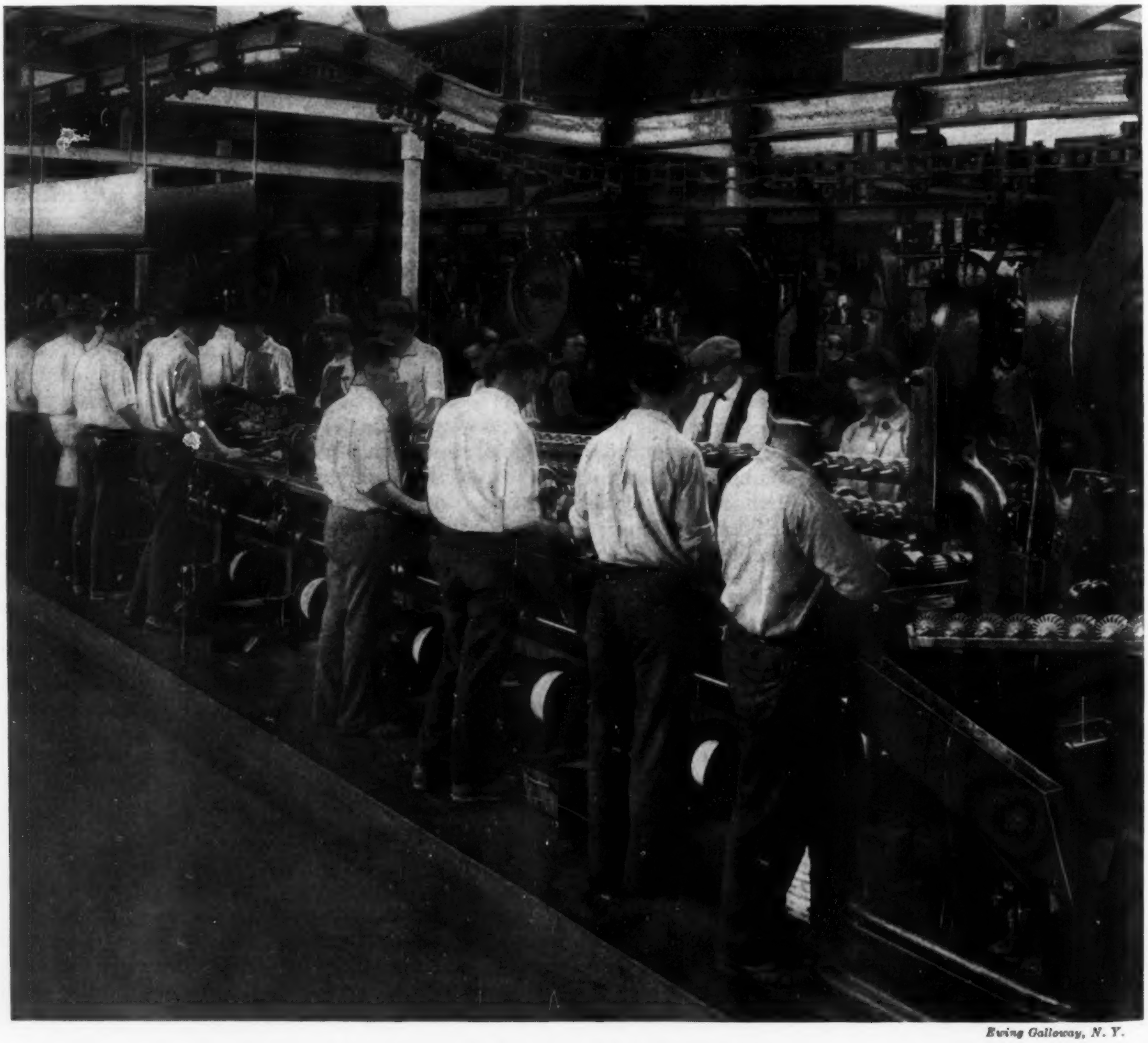
d Consider this minimum volume as normal, and meet increased demands by overtime or additional regular hours of labor

e Measure all efforts and reward them in terms of their contribution to the ultimate profitableness of the business

f Put aside for all time the "volume complex"

g Consider just as essential as insurance:
Maintenance of employment
Building up strong cash reserves
Adequate research

h Develop a spirit of cooperation within each industry rather than competition.



Ewing Galloway, N. Y.

MASS PRODUCTION REQUIRES MASS CONSUMPTION

If production is attributed properly to consumption, the fluctuation of consumption will be relatively limited. Engineers, who have made an intensive study of production with remarkable success, now realize, as Mr. Bigelow says, that our problem for the future is to balance production against consumption.

PUBLIC WORKS *During* TIMES OF DEPRESSION

By GEORGE L. HOXIE[1]

WHEN one considers what public actions should be taken during a depression, the first question to be answered is whether the search is for a temporary palliative or for a cure. Palliatives must be administered with great caution if, as is usually the case, they tend to check the operation of natural curative forces.

Sedatives have their important uses. Drugs, opiates, and anesthetics are at times highly necessary. A sufferer on the battlefield is given morphine, not to heal his hurt but to relieve his suffering while he waits for the surgeon. So in commercial life it may be necessary to ease distress by the opiates of short weeks and the "spreading" of work among excessive numbers of men, by public constructions that would not otherwise be undertaken, and so forth. But disaster lies at the end of such programs unless full account be taken of the fact that those measures are temporizing palliatives that delay cures.

CAUSES AND CURES

An opiate, either physical or business, leaves the patient weaker. The sufferer, once the blessed relief of the first injection of morphine has worn away, demands another dose. Such drugs are habit-forming, and the opium habit is death.

Depressions follow causes. There may be bitter controversy over causes, yet no one denies that an observed result must have been preceded by circumstances that permitted no other outcome. The military command "As you were!" if it could be obeyed, would only result in duplicating the situation that made the trouble. If an opiate makes a suffering nation sleep instead of energetically trying to readjust itself, then there is harm rather than benefit. If, on the other hand, palliative measures can be put into effect without unduly checking the forces that normally work toward recovery, that program may on the whole be beneficial. When, as is now the case, such measures both relieve the pain of readjustment and delay the coming of prosperity, then the question is, How much can we afford to lengthen a depression as the price of allaying a proportion of its pain?

THE PUBLIC PAYS

If, during the boom, the Government had provided for the financing of a large number of useful projects to be built during an ensuing depression, that policy would have somewhat checked the boom and would have measurably lightened the subsequent distress of the depression. We have quite a different situation when financing can only be effected by taxpayers who are put to it to make ends meet. In the long run, costs must be met by consumers. To think otherwise is delusion. The consuming public is the only possible paymaster. Payment may seemingly be delayed, or its burden may in the first instance seem to fall only upon selected classes, but those facts do not alter the invariable rule that the public must pay in the end.

POPULAR DELUSIONS

Comprehension of the major factors of a problem is occasionally aided by employing some hypothesis that grossly exaggerates the actual circumstances. A major question related to the policy of trying to bring prosperity by means of vast public constructions, is, What happens at the end? Whatever the available funds, unlimited expenditure will exhaust them eventually. What then?

Some take it for granted that overturned business is capable of righting itself of itself *during a period within which public constructions maintain the status quo of the very circumstances that brought hard times*. The thing is impossible. To state it is to deny it. A second major question, then, may be stated thus: Assuming a public-works program big enough to make a substantial dent in unemployment; can private making, serving, and trading increase enough during the execution of such a program to fill the gap when public construction stops? Perhaps the answer may be viewed through the telescope of exaggeration.

Let us assume that there are resources adequate to build public works in such volume as to use the services of all unemployed, to put prices back to the 1929 level, and to make all classes in the nation apparently as prosperous as if a great war were being waged. Let us assume that these resources are so liquid that every item of existing wealth could be siphoned into public works until nothing else remained. Construction could then be made to go ahead under full steam until the last dollar had been so transferred. But hardly any one would then be able to exist except as those public works furnished him sustenance.

TAXES DO NOT BUILD WEALTH

An illustration so extreme as to be fantastic sometimes serves to fix attention upon the essence of a milder plan that looks in like direction. Only a minor fraction of the wealth of any nation is or can be made liquid. The

[1] Consulting Engineer, Los Angeles, Calif. Mem. A.S.M.E.

only things that can be built into physical structures are raw materials from the earth, the use of plants that transport and fashion those materials, the labor of men all along the line, including the labor and the use of machinery to supply food, clothing, shelter, comfort, and amusement to those more directly employed on what is being built.

To the degree that such things and services are diverted from trade to non-profitable public works, trade must suffer. To the degree that the same elements are shifted to profitable public works, private business is shifted to government-in-business—to socialism.

"But," a critic replies, "we are in a depression. Precisely those things and services are drugs on the market. Admittedly it would be better not to interfere if trade were active. With things as they are, why not use idle men and idle materials to build structures for the Government?" To answer this question requires some preliminary analysis.

READJUSTMENT

Trading, or the making and exchanging of goods for other goods, of services for services, and of goods for services, can never slacken so long as each party to each trade gains something from that trade. When business slows down it is only because trading inequities (mostly price inequities) have developed that compel the less fortunate to part with more value than they receive, if indeed they trade at all. Even that sort of trading may persist for a long time. Finally, however, the submerged classes have spent their savings and mortgaged their hoped-for future wages. Then comes an abrupt stop and a crash.

To restore trading, to arrange matters in such a way that what a man makes or does will pay for what he must get from others, requires a painful readjustment. Temporarily to reemploy all, at Government expense, would maintain the status quo until the Government's (taxpayers') resources were exhausted. Then, indeed, real disaster!

Readjustment calls for relative increases of rewards among the lowly; for relative decreases for the aristocrats among workers and for too prosperous capital. Left alone, economic law works out such new relations through foreclosures, bankruptcies, wage cuts for high-priced workers whose products do not sell at the old prices, for shoals of middlemen, relative idlers, and so on. Readjustment through Government action usually takes the form of inflation of the medium of exchange. Palliative measures that delay readjustment generally come in the guise of unneeded Government constructions.

Within the limit of what the depressed taxpayers can really afford, and within that highly sensitive limit of what will not unbearably delay a new prosperity, such public constructions may be tolerated for a time. Palliatives ease the strain. It has been demonstrated that a man can move more pig iron in a day if he takes intermediate rest periods. Social readjustments may follow a similar law.

The preceding limits are narrow. Every nail used by Government must be paid for by some taxpayer who, if permitted, might have preferred to use that nail for something useful in private trade. True, the taxpayer might not, on his own account, buy the nail at all. To make the individual buy, the price must be low enough to promise some gain. If nails are bought by Government at the old prices, and if those prices are beyond the trading capacity of farmers and other submerged groups, then each nail used by Government delays the inevitable drop in the price of nails to a point where trading can be resumed. Thus Government may postpone the readjustments that must precede recovery.

LUXURY SPENDING

Nothing is more fallacious than the notion that Government costs can be shifted to the rich through high income and inheritance taxes. There may be some gain if the rich are forced to limit their personal luxury spending. It will appear in a moment, however, that even that possible gain is questionable. Except for the luxury fraction of a great income, every dollar of a rich man's gains must be invested in something, and that something—if his plans work out—involves the stimulation of trade. The case as regards confiscatory inheritance taxes is yet more striking.

A large estate does not consist of gold; it is made up of fractional interests in land, buildings, manufacturing plants, railroads, electric systems, ships, and the like. The Government will not take an undivided interest in any one of these in payment of an inheritance tax. Even if the Government were willing to accept payment in kind, not the properties but only the current productions of the properties could be put into public works. Those current productions would otherwise have gone into private trade. Government commandeering, therefore, is always a check upon business.

David Cushman Coyle, in MECHANICAL ENGINEERING for September, quite correctly draws attention to the fact that something like a quarter of our available labor may soon be sufficient for the utilization of all of our available power and raw materials. The remaining workers, then, if employed at all, must devote themselves to supplying a luxury market. The proportion of workers necessary to produce and transport for all the minimum of food, clothing, and shelter needed to sustain life, probably would not, if efficiently organized, be more than ten or fifteen per cent of all workers. Except for our still vast capacity to spend for comfort and luxury as well as for necessities, our present social organization would disintegrate completely.

PRIVATE PURCHASING POWER MUST NOT BE LESSENED

Extreme caution must control every act that might, through added tax burdens anywhere, check in the slightest degree private purchasing power, whether luxury or other. A large-scale program of Government constructions is peculiarly dangerous during a period of depression.

SKIDDING REDWOOD LOGS IN SEQUOIA NATIONAL PARK

FAITH *in* RESEARCH

By ARTHUR KOEHLER[1]

RESEARCH is a systematic exploration of the unknown. Such recent and familiar products as cellophane, bakelite, rayon, irradiated foods, and sound pictures are not the result of a hit-or-miss search, but are the fruit of systematic exploration performed in research laboratories. Or, to bring the subject closer to the wood-using industries, the drying of lumber with a minimum of stresses and degrade, the instantaneous determination of the moisture content of wood by the electrical method, the tremendous growth in the use of plywood because of the increased water resistance of various glues as well as improvement of gluing practices in general, the great increase in strength and decrease in weight of wooden airplane parts, the expansion in the manufacture of wall board and other insulating material from wood, the extensive use of aluminum powder in priming coats and of lacquers in finishing coats, and the development of high-speed woodworking machinery are all the result of research. Ages of trial-and-error, or rule-of-thumb, methods could not have brought about most of these revolutionary developments.

DOES RESEARCH PAY FOR ITSELF?

Does research pay for itself? One need only consider the widespread use of many inventions based on research to answer this question. An enumeration of the industries that have grown in the last 25 years also recalls those which have been backed by research. The increase in the number of research laboratories in the chemical, metallurgical, textile, and other industries also attests that research pays.

The keenest competition today is between revolutionary ideas. What the manufacturer of today fears is not so much the competitor who may shade production or selling costs a little, as the manufacturer who may virtually put him out of business by getting out something radically new that the customer prefers. Winter follows summer with such regularity that for years the iceman thought his market secure, but research, which produced the electric refrigerators, is today painfully teaching him otherwise. Research, as is clearly evidenced by our successful and larger indus-

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For presentation at the National Meeting of the Wood Industries Division of the A.S.M.E., Jamestown, N. Y., November 15 and 16, 1932.

tries, is the most effective weapon wielded in the warfare of industrial competition. Research is becoming more and more essential to hold old markets and create new ones.

WHEREIN INVENTION AND RESEARCH DIFFER

Right here it is well to point out the difference between invention and research. An invention is the application of known facts and principles in a new way. For example, the steam engine, self-binder, sewing machine, and even the automobile to a large extent were inventions based on known mechanical principles. Research, on the other hand, is the search for new facts and principles which may subsequently be used in inventions. The discovery of bacteria brought to light a hitherto unknown fact on which the use of antiseptics is based and which makes possible aseptic surgery and the preparation of serums that have saved millions of lives; the development of anti-knock gasoline is the result of the discovery of the real cause of "knocking" in internal-combustion engines; the strength of rayon yarn was tripled by the discovery that the molecules could be "oriented" parallel to each other and to the length of the yarn, as revealed by x-ray diffraction patterns, by applying tension to the yarn while coagulating; and the radio tube was the result of the discovery that heated metal emits electrons which carry with them various electric charges.

New inventions are possible without research, and the Patent Office attests that they are made daily, but by and large, invention must wait on research. Without the discovery of new facts and principles for inventors to use, invention would gradually decline. Frequently one scientific discovery can be used in numerous diverse inventions. For example, the electromagnet is used in telegraph and telephone instruments, armatures of dynamos and motors, electric bells and buzzers, magnetic hoists, arc lights, automatic controls, and the like. Research, however, is not concerned with physics and chemistry only. It may be purely mathematical, such as determining by statistical analysis the relationships of wage scale and length of working day to production, or the relationship of distance traveled by salesmen and costs by automobile and train. Working out such relationships brings to light new facts and principles, hitherto unknown.

FIELD FOR RESEARCH IN THE WOODWORKING INDUSTRIES

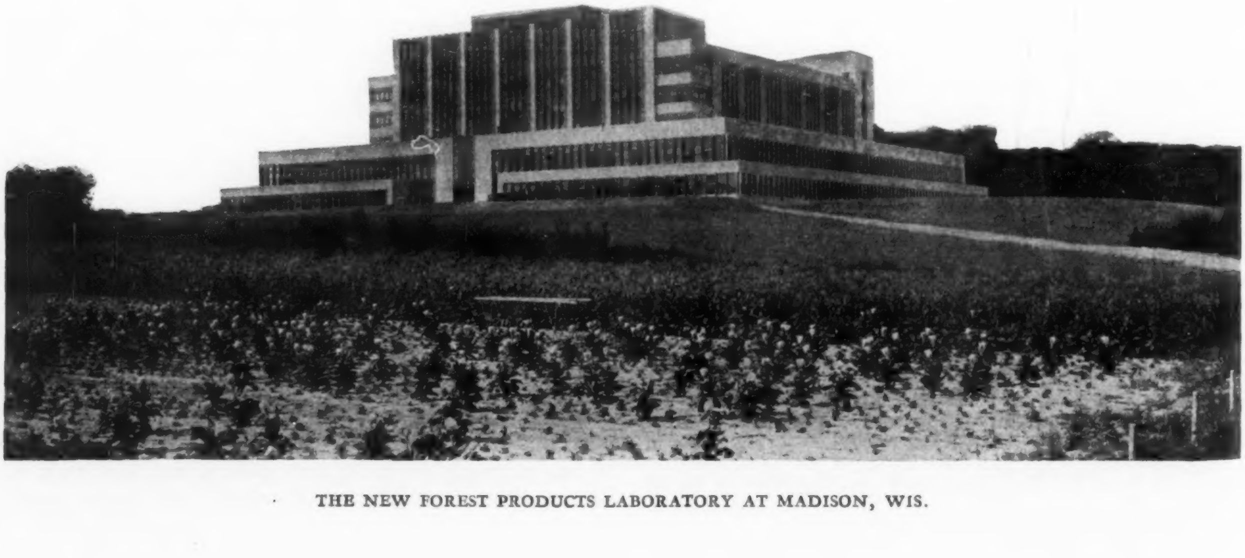
What can research do for the woodworking industries? Surely, it cannot be said that the furniture, piano, automobile-body, interior-finish, woodenware, handle, and sign manufacturers have no problems in connection with the wood they use, or that the problems they have cannot be solved. One need only reflect on the tremendous difficulties that had to be overcome in perfecting the rubber tire, phonograph record, electric-light bulb, photographic film, colored movies, and the like to feel confident that almost any reasonable objective can be attained by research.

The following are some of the problems of interest to furniture manufacturers and other wood-using industries that are now receiving attention at the Forest Products Laboratory:[2]

An effort is being made to find a treatment of wood that will prevent or greatly reduce its shrinking and swelling in use. If the tendency to shrink and swell can be largely eliminated, then wood will rank the equal of most competitive materials in this respect, and will be preferable in many other ways. The reduction of shrinkage in drying lumber would also be of great benefit to the wood-using industries since it would eliminate most of the seasoning difficulties, such as checking, warping, case-hardening, and honeycombing, with the resulting possibility of speeding drying, and of even drying types of wood that at present cannot be dried satisfactorily.

Making wood fire-resistant would add to its advan-

[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.



THE NEW FOREST PRODUCTS LABORATORY AT MADISON, WIS.

tages in many uses. Although of primary interest in building construction, it is also important in furniture to be used where regulations prevent the use of inflammable material. Efforts are being made at the Forest Products Laboratory to find fire-retardant treatments that are cheap, non-corrosive to metals, non-leaching, and otherwise not objectionable. Several combinations of chemicals give promise of overcoming these disadvantages.

Although research has brought about great improvement in the manufacture, preparation, and use of glues in the last decade, with the resultant production of articles of unusual form, dimensions, and properties, nevertheless the Forest Products Laboratory at present is endeavoring to increase further the efficiency of glues by prolonging their resistance to disintegration by water, bacteria, and fungi.

An effective and economical method of reducing blue staining of lumber has long been sought by the lumber manufacturer. Recently the pathologists of the Bureau of Plant Industry stationed at the Forest Products Laboratory have been instrumental in testing out new preventives for blue stain in lumber. As a result a new and highly effective chemical treatment has been developed which has sprung into use on a commercial scale in over 100 mills in this country, Cuba, Mexico, the Philippines, and Canada, and clear, bright lumber is now readily available to meet the demands of the wood-using industries.

It is well recognized in the wood-using industries that some of the southern hardwoods give considerable difficulty in seasoning, manufacture, and use, yet little definite information is available as to how the southern cousins compare with their northern relatives, or how the bottomland species of hardwood in the South compare with those in upland regions nearby. A survey of the properties of southern hardwoods is under way this year for the purpose of guiding manufacturers in the better selection and use of these species.

Probably the most revolutionary results of research in wood will come from the development of new uses for wood. Small-scale experiments on the possibilities of forming plastic compounds from chipped wood or pulp fibers indicate great possibilities. If such compounds could be developed so that they could be made into panels, tile, molding, and a variety of products which could be sawed or otherwise shaped, and which would shrink and swell but little, and could be varied in color, they undoubtedly would find a ready market. For example, a table top or mirror frame made from such material would have advantages not easily duplicated by other products.

In addition to these activities of direct interest to the woodworking industries, the Forest Products Laboratory is engaged in other research problems in wood preservation, exterior painting, building construction, fiber-board containers, pulp and paper manufacture, and fundamental studies of wood as a raw material, such as its chemical and physical make-up

These are only some of the many problems that con-

Ewing Galloway, N. Y.

SKIDDING LOGS AT JAMMER WITH 60-HP TRACTOR, WESTWOOD, CALIF.

front the timber owner and the manufacturer and user of wood products. There are many other research problems that need to be investigated if wood and wooden products are to hold their markets in a highly competitive field. The following are a few of the problems which are of interest to the secondary wood-using industries, such as those making furniture, automobiles, and pianos.

PROBLEMS AWAITING SOLUTION

A method should be devised for hardening the surface of wood so that some of the softer and otherwise desirable species can be used where resistance to wear and indentation but not a high degree of resistance to breaking are important, as in furniture, cabinets, flooring, and finish.

Improvement is necessary in joints and fastenings for wood in furniture and auto bodies, as well as in heavy construction on which some effective research is under way, since the joint usually is the weakest part of a wooden structure. Research on design of joints and the use of accessory fasteners, such as glue, dowels, nails, screws, and metal fittings, is much in need.

The possibilities of making wood more attractive in appearance by improving its color through transparent dyes or treatment with gases, such as ammonia, or by increasing its luster either by the use of transparent coatings with the best optical properties for the purpose, or by treatment of the wood itself, are practically untouched by research. If the luster of the gum woods

could be increased so that their ribbon grain would stand out as it does in mahogany, the value of these woods for decorative purposes would be greatly enhanced. Much additional work also needs to be done on finishes for woods used in interiors so as to make them more moisture-resistant and lasting, as well as to reduce their cost of application.

If the permeability of wood to liquids could be increased so that preservatives, fire retardants, coloring liquids, and other chemicals could be injected more readily, it would be a far step in advance in a number of industries depending on wood as a raw material. Tentative experiments at the Forest Products Laboratory indicate that this may be possible by the preliminary treatment of wood with certain gases.

More needs to be known about the ease with which different kinds of wood can be worked and the effect of moisture on this property, so that woods can be more judiciously selected from the manufacturer's standpoint.

POSSIBILITIES IN THE IMPROVEMENT OF WOODWORKING MACHINERY

Undoubtedly the last word has not been said in woodworking machinery. Such matters as shape of saw teeth, bevel of planer knives, speed of cutters, and speed of feed have been developed empirically, no one knowing why present practices are what they are except that they give usable results. How much these results could be improved is not known, because the possibilities in this field have not been scientifically studied. Suppose some one were to invent a planer which left no planer marks; such an invention would do away with the necessity of sanding and with much of the raised grain which now troubles wood finishers.

The subject of raised grain alone is an important field for research. How does it vary in different kinds of wood, with the moisture content of the wood, with coarseness of sandpaper, and speed of sanding? What are the best methods of coping with it when it does occur?

Similarly, more needs to be known on the effect of moisture content and of temperature on steam bending so as to reduce breakage and allow a minimum amount of time for the bent wood on forms.

What temperature is necessary to sterilize wood so that all wood fungi within are killed?

What effect does steaming lumber have on its subsequent durability?

How can the ravages of white ants be prevented in woodwork in warm climates?

How can paint be made to stick better on the hard summerwood of softwoods?

How can short lengths of lumber be used most economically?

What is the smallest-sized tree that it pays to cut?

These suggestions have been confined primarily to wood and immediate accessory materials. There is room for research in the fields of costs of handling material, personnel, accounting methods, sales, and distribution.

There are many opportunities for research in woodworking plants, especially in applying to their specific needs the results obtained at experimental-research institutions. The results of such applied research can often be patented to the advantage not only of the individual or firm concerned but to the public as well, since the Government through its issuance of patents acknowledges the value of new developments to the public.

Research, however, has broader application than immediate benefits. Research on wood, for example, cannot help but make wood serve the public better, thereby keeping it in demand as a raw material for manufacturing purposes. Demand for wood means a market for timber, which can be grown on the millions of acres of land better suited for growing forests than for other purposes. The use of this land for timber growing means not only industrial development with its attendant employment of labor, contribution to taxes, and permanent communities, on otherwise worthless territory, but in many cases it also means the conservation of the soil, water, and recreational facilities, the importance of which is more and more being recognized.

RESEARCH THE CHIEF BASIS OF NEW DEVELOPMENTS

There is another aspect of research which is only beginning to be appreciated. Research is the chief basis of new developments, not only in industry but in economics, sociology, and medicine. New developments are the basis for prosperity and improvement in living conditions. Today the need of aggressive research in order to pull many wood industries out of this depression through industrial improvement is more urgent than ever before. The solution of the problem of economically housing the masses would bolster up the furniture and many other industries and otherwise stimulate trade. Prosperity rests on improvement in our standard of living; improvement rests on research—yet, paradoxical as it may seem, not only private concerns but state and federal governments are cutting down on research just when we need it most.

Here is another sidelight on research. We hear a great deal about overproduction and shortening working hours these days. There is no danger of overproduction in research. Sometimes we think that we are smart because of the material progress we have made in the last half-century, yet we know only an infinitesimal amount of what is to be known. The more we know the better we can live. It is the woeful shortage of economic research that leaves us without a sound preventive or remedy for recurring industrial depressions such as the one we are now experiencing. There are many suggested "cures," but they are based to a great extent on superficial thinking, prejudice, and ignorance of the underlying causes, and not on a systematic exploration of the unknown.

We need more faith in research. It need not be a blind faith either, for the past has given us abundant evidence of what research may bring forth.

THE ECONOMIC CHARACTERISTICS OF THE MANUFACTURING INDUSTRIES

By WALTER RAUTENSTRAUCH[1]

An Analysis of the Costs of Production, Management, and Merchandizing of Commodities at Varying Rates of Output, Upon the Basis of Which a Graphic Portrayal of Their Relationships to Plant Capacity Utilized Is Set Up.

EVERY manufacturing enterprise has certain definite characteristics of costs, earnings, and investment in plant, in relation to its productive capacity and the rate of operation or use. The steel industry differs from the lumber industry; a cement plant differs from a flour mill; and units in the same industry differ from each other in respect of their economic characteristics. The water-rate curves of reciprocating engines and steam turbines have been used for a long time as bases for comparing their economic worth. Not only are such comparisons made between individual prime movers and converters of energy, but entire plants are thus studied and compared. Accordingly the costs per unit of output at different capacities used have been established for specific steam plants as compared with hydroelectric installations and with oil-engine plants of the same and different capacities.

While such studies have been made in the field of power generation and distribution, it is unfortunate that the same sort of comparisons are not in common use in the manufacturing industries. The performances of such industries are usually judged from their balance sheets and operating statements, and useful as these records are, they unfortunately fail to disclose a comprehensive picture of their economic characteristics, that is, their probabilities of profit or loss at varying rates of production and sales.

This paper is presented in the interest of obtaining a wider acceptance of the use of a graphic method of portraying the economic characteristics of specific manufacturing businesses, of comparing one business with another by such graphic analyses, and to show how such analyses may be used to formulate executive policies in the control of business affairs.

The analyses given herewith have been used by the author for many years in his classes at Columbia University, and also while consultant for and manager of a variety of manufacturing enterprises.

GENERAL COST FACTORS

In general, there are three main cost classifications associated with the economic consideration of any industrial undertaking, and these are:

1 The Cost to Procure
2 The Cost to Possess
3 The Cost to Operate.

The Cost to Procure is that cost which is included in assembling the units of a business and creating therefrom a business enterprise. It includes the purchase price of equipment, transportation costs, placement costs, and all other expenses occasioned by the creation of the business. It may include legal and other professional expenses.

The Cost to Possess is that cost which arises from the ownership of the property, from value changes which are a function of time, and from other costs which the possession of property incurs. The items of the cost to possess are interest, taxes, depreciation, and insurance.

The Cost to Operate arises from the functioning of the business as an economic enterprise.

The cost to procure establishes certain factors conditioning the cost to possess. There is no general relation between the cost to procure and the cost to operate. A low cost to procure may occur with a high cost of operation or a low one. For an existing business, of which the cost to procure has been established, the economic problem of production and distribution is concerned with the cost to possess and the cost to operate. This paper is therefore concerned with these two principal categories of cost.

COST CHARACTERISTICS IN THE MANUFACTURING INDUSTRIES

Upon examining the items of the total costs or expenses of possessing and operating a manufacturing business, we find that certain ones are not affected by the rate of production or the volume of goods produced in a given time period. These items are rent, fire insurance, taxes, depreciation, interest on borrowed money, and certain salaries and other expenses which are fixed by executive policy. It is important to note that some are constant as fixed by the inherent nature of the enterprise, such, for example, as rent, taxes, fire insurance, depreciation, and interest on borrowed money; others, such as salaries and expenses for advertising, are determined by executive policy. These latter may be changed to lower or higher levels if the management so elects. The former can be changed between certain limits only by the reorganization or redesign of the factory. Therefore, while a business when examined at any particular time will be found to be operating with certain constant total costs, it is to be noted that a portion of these costs admit of being raised or lowered by executive action and others are determined by the design features of the factory, the machinery of manufacture, and the financial structure of the enterprise.

[1] Professor of Industrial Engineering, Columbia University, New York, N. Y. Mem. A.S.M.E.

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These costs are referred to as Constant Total Costs and not simply as constant costs, because the use of the word "total" is necessary to distinguish these costs from Constant Unit Costs later referred to.

We next observe that after the Constant Total Costs, there remain some total costs which tend to vary directly with the volume of business done during a given time period. Principal among the Variable Total Costs are materials and labor. Since our analysis is concerned with general relationships and trends, differences in materials costs due to lower prices at the larger volume of purchase are not usually significant.

The total labor cost tends to vary directly with the volume of work produced in a given time. This is particularly true when the product is made largely by labor and not by automatic machines. When set-up time for operations is a large factor in the time of processing and since short runs require the same set-up time as long runs, it appears that as production under such circumstances is reduced, the total labor cost may not vary *exactly* as the rate of production. The productivity of labor also varies to some extent, and the variation may be considerable under different managements. In the main, however, the general tendency of total labor cost in a given time period—a month, for example—and under a given management, is to vary directly with the output during that time. Therefore, in most instances if the total labor cost to produce 1000 units per month is $2500, that required to produce 500 units per month should be approximately $1250.

As we examine the nature of other total costs we find they are partly constant and partly variable. When salesmen are employed on a salary plus commission, the salary portion of selling cost will be constant over a given period of time, while the commission paid will vary directly with the volume of goods sold during the time. In the case of power, we find a certain constant total cost due to keeping the shop running at no load, but as more power is consumed in the productive processes, the amount—and hence the cost—will vary directly with the rate of production. Certain items of factory expense such as for indirect labor for moving materials about and for other services, will tend to rise as the rate of production increases. So also we find the same tendency in the consumption of indirect materials such as expendable tools, oil, and supplies which are consumed during the process of manufacture. It is not always apparent in the case of the expenses just referred to and in other similar cases, just what portion is constant and what portion varies directly with the volume of production. A reasonably intelligent apportionment between constant and variable total costs may be made with respect to each item of expense by inspection and experience, and with sufficient approximation to indicate a general tendency or trend.

Net sales		$2,500,000
Cost of goods sold:		
Material	$300,000	
Labor	500,000	
Factory expense	750,000	
Total		1,550,000
Gross profit		$ 950,000
Administrative expense	$200,000	
Sales expense	500,000	
Total		700,000
Operating profit		$ 250,000

As a general rule it is not possible to take the published statements of a company and without any experience with its details of operation arrive at a satisfactory segregation into constant and variable total costs. Any attempt to base an analysis of the economic characteristics of a business on a published statement only, must necessarily result in very rough approximations, and these are sometimes worse than useless because they are misleading. For example, see the annual operating statement of a certain compamy given at the bottom of the preceding column.

We have used round numbers for simplification. This statement gave no indication of a proper division between the constant and variable total costs, and it was only by a most careful examination of each item of factory expense, consisting of some 32 details, and of sales expense, consisting of 12 details, that we were able to establish the following apportionment of total costs.

Item	Total cost	Constant total costs	Variable total costs
Material	$ 300,000	....	$ 300,000
Labor	500,000	....	500,000
Factory expense	750,000	$450,000	300,000
Administrative expense	200,000	200,000	....
Sales expense	500,000	250,000	250,000
Total	$2,250,000	$900,000	$1,350,000

The average capacity utilized during the year was 80 per cent.

THE "BREAK-EVEN" CHART

With these data, the economic characteristics of the business are graphically determined as follows: As shown in Fig. 1, the base of the chart is laid out to convenient scale in terms of plant capacity and the ordinates are laid out to the scale of 1 unit equals $100,000. Upon the 80 per cent plant capacity ordinate the constant administrative expense [Adm(C)] and the constant portions of the sales expense [Sales (C)] and factory expense [Fact Exp (C)] are laid off successively. Horizontal lines are drawn through these points. Continuing along the 80 per cent capacity ordinate the Variable Total Costs as indicated are laid off successively and through these points are drawn the several oblique lines. In this manner, the probabilities of total costs at different plant capacities utilized are established. For example, the Total Cost of operating the business for one year at 50 per cent capacity is about $1,750,000, and at 100 per cent capacity, about $2,600,000. The details of these total costs may also be approximated from the chart. For example, when the plant is operated at 50 per cent capacity for one year, the annual labor cost should be about $320,000, and at 100 per cent capacity, about $640,000. If now, the income line is constructed by passing a line through the origin and through the income point ($2,500,000) on the 80 per cent capacity ordinate, it is found that the intersection of this line with the total-cost line establishes the probability that the business will "break even" at about 63 per cent capacity, or when sales equal ($2,500,000/0.80) × 0.63 or $1,970,000. This may also be read directly from the chart. Accordingly if the business continues to be operated by the policies which establish these costs, then it will be profitable between about 63 per cent and 100 per cent capacity.

In some respects this chart may be likened to a tangent to the curve of business conditions, in that it shows a tendency or trend of direction at a given time and under given conditions. That is, if the conditions found at 80 per cent plant capacity, from which the data for constructing the chart are obtained, should be maintained throughout the entire range of plant capacities, then the probabilities of costs are as defined by the chart. In view of the fact that certain of the Constant Total Costs are fixed by executive policy, it is natural to suppose

that with a decline in sales, certain curtailments of the Constant Total Costs in the way of the salaries and the number of fixed employees will result, and therefore the Constant Total Costs at the lesser plant capacities utilized will stand at lower levels.

The effect of any changes in either Constant Total Costs or in Variable Total Costs may be plotted on the break-even chart and the probable resulting differences between income and expenses determined. Suppose, for example, that when the business declines and reaches the break-even point, a reduction of 10 per cent in the salaries of the officers is made, the office help is reduced, and other measures are taken to lower the Constant Total Costs to $800,000 annually. A new chart superimposed on the original one, as shown by the broken lines in Fig. 1, shows that this change has lowered the break-even point to 56 per cent of plant capacity and that instead of just breaking even at 63 per cent plant capacity, a profit of $100,000 annually may be realized.

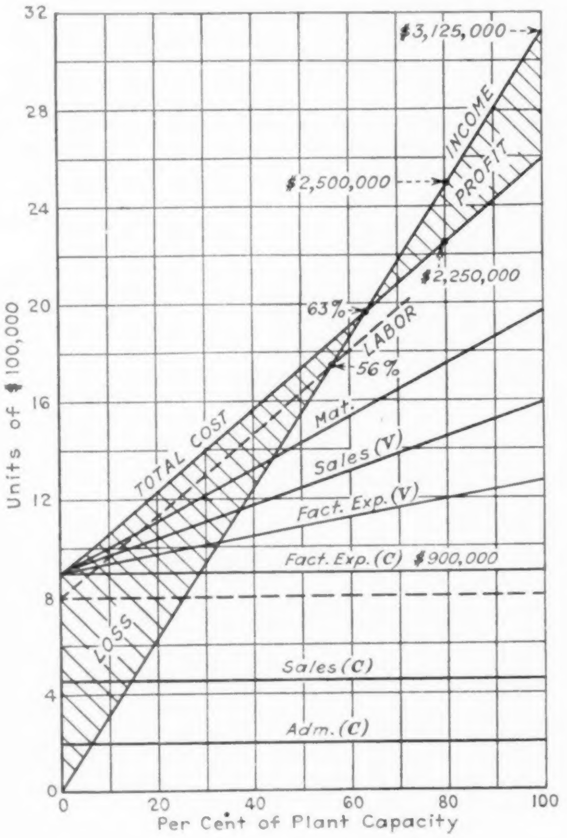


FIG. 1 THE BREAK-EVEN CHART

A few of the useful purposes which this chart may serve are set forth in what follows.

1—COMPARISON OF SALES, COSTS, AND PROFITS WITH THE BUDGET

It will be noted that the break-even chart is in reality a graphic budget of income, costs, and profit at varying rates of production, and as such may be used as a basis of comparison with the results of performance. Fig. 2 shows the portion of a break-even chart covering the profit area that was laid out for a yeast company. This record is reproduced from the original as kept by the general manager of the company, and is for an entire year. The company sold a by-product and hence the income line from the sales of yeast is just under the total-sales line. It will be noted that the monthly costs varied slightly from the budgeted cost line and at a rate to indicate that perhaps some of the costs which were assumed to be constant did in fact vary with the rate of production. The correspondence of actual cost with the budget is very satisfactory. The monthly report of the management to the directors included a chart like that illustrated in Fig. 3. This chart showed that the sales in pounds for the month were under the budget; that the income from the poundage sold exceeded the estimated income for this poundage; and that the various items of cost closely approximated the budget expectations. The left-hand edge of the shaded diagram of the "sales dollar" is the line to be compared with the coinciding ordinate of the break-even chart. The width of the "sales dollar" diagram is not significant. This chart gave the directors very complete information on the company's operations for the month.

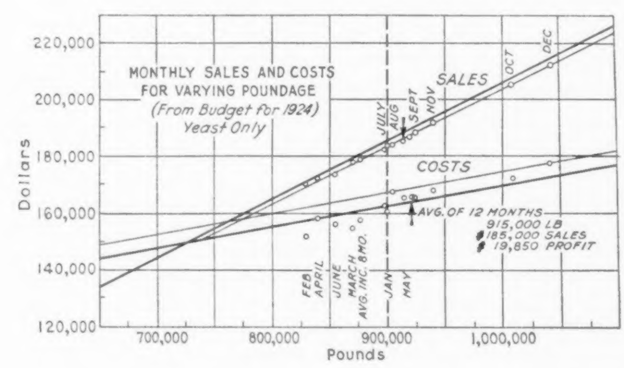


FIG. 2 PORTION OF BREAK-EVEN CHART, FIG. 1, COVERING THE PROFIT AREA

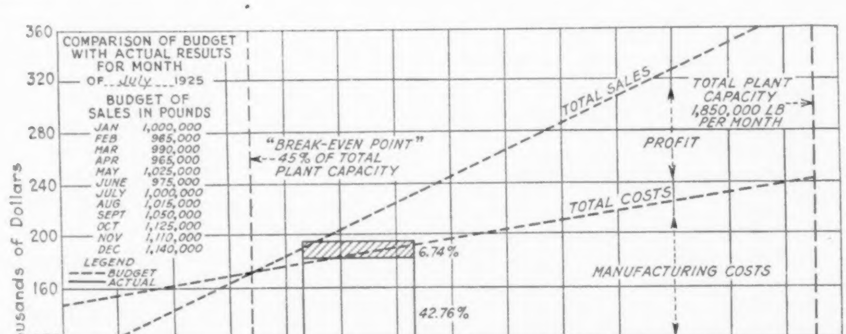


FIG. 3

II—DETERMINATION OF THE PROBABLE UNIT COST AT VARYING RATES OF PRODUCTION

It is sometimes helpful to draw a curve of the unit cost of a product at different rates of production in order to forecast quickly the effect on profits when a change in unit selling price is made. A recent investigation made of a beet-sugar company will serve as an illustrative example. During the course of this investigation the following data were obtained:

The average sugar content of the beets was $14^1/_2$ per cent. Of this amount only 85 per cent could be extracted after allowing for a 6 per cent shrinkage. One ton of beets was found to yield 100 lb (5 per cent) of dried pulp and 32 lb (1.6 per cent) of molasses. The selling prices of the products were as follows: Granulated sugar, 6c per lb; molasses \$8 per ton; dried pulp, \$30 per ton. The capacity at which the mills were operated was 200,000 tons of beets annually. It may be noted that beet-sugar mills run for a period of three to four months during the year, generally from the first of October to the first of February. They are idle during the remainder of the year, and the time is spent in making repairs and renewals. A skeleton crew is maintained during the idle period. The period of operation is known as the "campaign." The total annual revenue is determined as follows: The amount of sugar packed from one ton of beets is $2000 \times 0.94 \times 0.85 \times 0.145 = 232$ lb. The annual production of all products is:

$232 \times 200{,}000 = 46{,}400{,}000$ lb of sugar
$200{,}000 \times 0.05 = 10{,}000$ tons of dried pulp
$200{,}000 \times 0.16 = 3{,}200$ tons of molasses

The annual revenue is:

Sugar, $46,400,000 \times \$0.06$ =	\$2,784,000
Molasses, $3,200 \times \$8$ =	25,600
Dried pulp, $10,000 \times \$30$ =	300,000

The annual costs are as follows: Growers' cost is based on a contract with the farmers or growers which provides that they shall be paid 45 per cent of the selling price of the sugar extracted from the beets they furnish, with a minimum guarantee of \$5.22 per ton for $14^1/_2$ per cent sugar content and 85 per cent extraction. Since the percentage on selling price prevailed, the mill owner paid the grower at the rate of $232 \times \$0.06 \times 0.45$ or \$6.26 per ton. Therefore the total cost of raw materials (beets) was $200{,}000 \times \$6.26$ or \$1,252,500. This clearly is a Variable Total Cost.

The costs of operation[2] were:

CONSTANT TOTAL COSTS OF OPERATION

Agriculture	\$ 175,000
Depreciation of agricultural equipment	15,000
Maintenance and repair of mills	125,000
Depreciation of mills	125,000
Factory and administrative expense	675,000
Total	\$1,115,000

VARIABLE TOTAL COSTS OF OPERATION

Freight and cartage	\$231,750
Unloading	15,000
Packing	1,000
Total	\$247,750

Interest charges, due to outstanding bonds to the amount of \$1,500,000 at 7 per cent, were \$105,000 annually.

Summarizing these costs, we find that the Constant Total Costs are:

Cost from operations	\$1,115,000
Cost from bond interest	105,000
Total	\$1,220,000

The Variable Total Costs are:

Growers' costs (beets)	\$1,252,500
Due to operations	247,750
Total	\$1,500,250
Less revenue from pulp and molasses credited to operations	325,600
	\$1,174,650

The annual sales are for sugar only, and are \$2,784,000. Revenues from pulp and molasses are not to be included in sales since they have been credited to operations as defined above.

The costs per pound of sugar at varying rates of production per annum are determined by the equation[3]

$$C = S\left(\frac{a}{X} + b\right)$$

$$= 0.06\left(\frac{1{,}220{,}000}{X} + \frac{1{,}174{,}650}{2{,}784{,}000}\right)$$

$$= 0.06\left(\frac{1{,}220{,}000}{X} + 0.42\right)$$

$$= 0.06\left(\frac{1{,}220{,}000}{X}\right) + 0.0252$$

Values of C for different annual rates of production are:

C (cents per lb)	Tons sliced per annum	C (cents per lb)	Tons sliced per annum
7.70	100,000	5.77	160,000
7.24	110,000	5.58	170,000
6.86	120,000	5.40	180,000
6.50	130,000	5.26	190,000
6.28	140,000	5.12	200,000
6.01	150,000	....	....

These data when plotted give the curve shown in the upper portion of Fig. 4. This figure also gives the break-even chart for the business, from which it will be noted that the profits of the latter are largely dependent on the revenues from by-products. If the mills were running at maximum capacity, 300,000 tons of beets per annum could be sliced. On this basis it appears from the chart that the business would break even at a tonnage (T) of approximately 152,000 per annum or 50 per cent of maximum capacity.

The law of vanishing profits[3] gives

$$X = \frac{a}{1 - b} = \frac{1{,}220{,}000}{1 - 0.42} = \$2{,}103{,}450$$

$$\text{But } T = \frac{2{,}103{,}450}{13.92} = 152{,}000 \text{ tons, approx.}$$

If the price of sugar should drop to $5^1/_2$ cents per pound, it could be determined from the curve that the break-even point would then be between 170,000 and 180,000 tons of beets per annum. If the price should drop to 5 cents, there would be a loss of 0.12 cent per lb if the mills were run at a capacity of 200,000 tons of beets per annum.

[2] Costs of operation in this example include some of the "costs to possess."

[3] For derivation, see Art. IV.

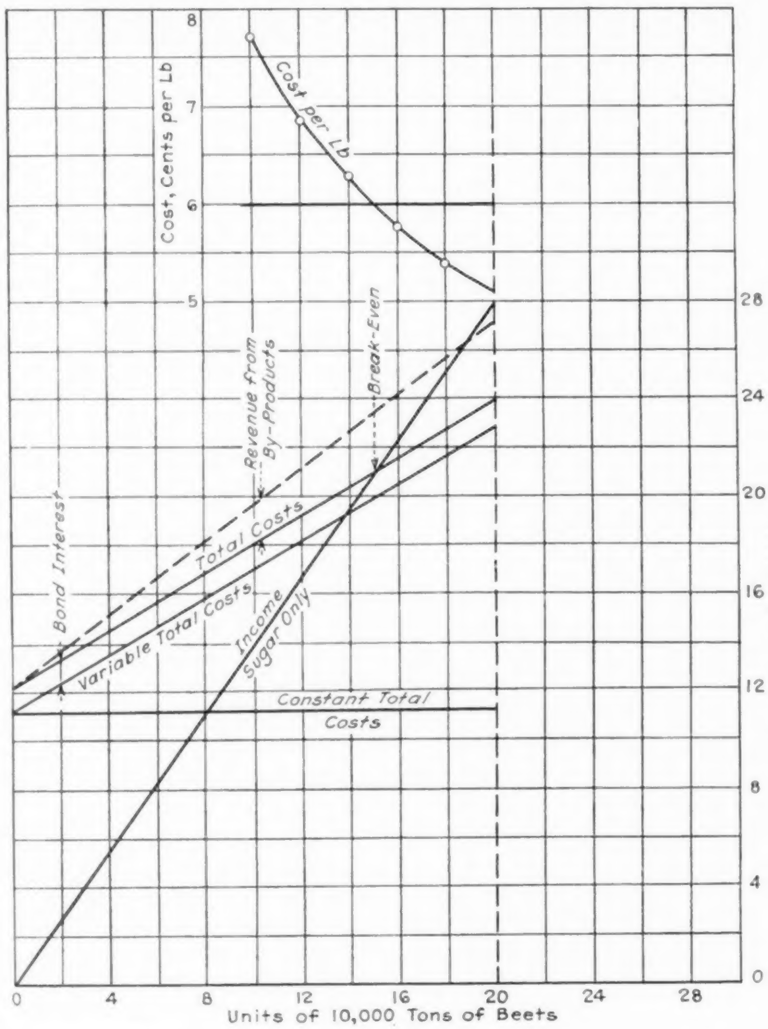


FIG. 4

III—THE PROBLEM OF DUMPING

When a manufacturer sells his products in another country than his own at the approximate cost of manufacture, he is said to be dumping his goods on the foreign market. By so doing he does not disturb the price situation in the home market, unless the goods are reexported and sold at home at less than domestic prices. He also increases his profits, even though he may sell these goods abroad at less than their cost. This situation may be studied by the use of a curve of unit costs.

Suppose, for example, that the unit-cost curve of a business is as shown in Fig. 5. When the business is operating at 60 per cent capacity the cost per unit of product is $8.80. At a selling price of $10 there is a profit of $1.20 per unit. It is found that this product may be sold abroad in considerable quantities at $5.50 f.o.b. the plant. By selling abroad at this price the manufacturer finds he can operate his plant at full capacity. But it appears that when the plant is run at full capacity the product costs $6 per unit to manufacture. How can the manufacturer afford to sell the product abroad at $5.50 when it costs $6 to produce it?

Let us examine this problem for a moment. It is true that there is a loss of 50 cents on all articles sold abroad, and that this loss is encountered on 40 per cent of the plant output. On the other hand, if the domestic market takes 60 per cent of the plant output, the cost of production having dropped from $8.80 to $6, it appears that the profits on the domestic business will be increased by $2.80 per unit. Accordingly, if there is an increase in profits of $2.80 per unit of product on 60 per cent of the plant output and a loss of 50 cents per unit on 40 per cent of the plant output, the net result is an increase in total profits. The net increase per unit on the domestic business will be

$$[(60 \times \$2.80) - (40 \times \$0.50)]/100 = \$1.48$$

Whether or not dumping on a foreign market is a good business policy to pursue is another matter.

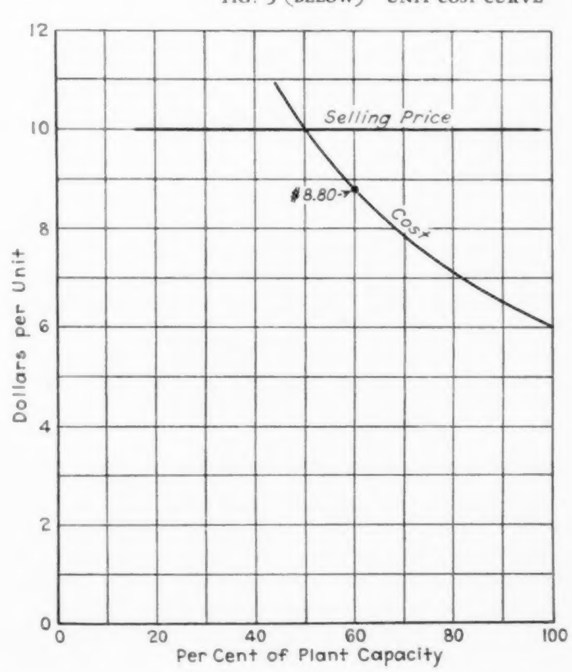
IV—DERIVATION OF THE ECONOMIC LAWS

The relationships shown graphically in the break-even chart may also be formulated symbolically.

The Law of Vanishing Profits. If the output of a plant, the abscissa of the chart, is measured in dollars of sales value instead of in percentage of plant capacity, and is designated as X, and the sales value, as determined by the ordinate to the income line, is designated as Y, then the income or sales line of the chart may be expressed as $Y = X$.

The total-cost line of the chart may be expressed as $Y_1 = a + bX$, where a represents the Constant Total Costs and b the ratio: $\dfrac{\text{Variable Total Costs}}{\text{Corresponding Sales}}$

FIG. 5 (BELOW) UNIT-COST CURVE



The company will break even at that volume of sales where the two lines intersect, or when Y is equal to Y_1. Accordingly, when $Y = Y_1$,

$$X = a + bX = \frac{a}{1-b}$$

That is,

$$X = \frac{\text{Constant Total Costs}}{1 - \dfrac{\text{Variable Total Costs}}{\text{Corresponding Sales}}}$$

EXAMPLE: A certain business operates with Constant Total Costs of \$550,000, and at 80 per cent capacity its sales are \$2,000,000 and the corresponding Variable Total Costs are \$1,200,000; at what volume of business will the company break even?

Solution:

$$X = \frac{550,000}{1 - \dfrac{1,200,000}{2,000,000}}$$

$$= \frac{550,000}{0.4}$$

$$= \$1,375,000$$

In terms of plant capacity, it will break even at

$$\frac{1,375,000 \times 0.80}{2,000,000} = 55 \text{ per cent}$$

The Law of Profits. The profits of a business may be determined from the equation

$$\text{Profit} = \text{Income} - \text{Total Costs}$$
$$= Y - Y_1$$

But since $Y = X$ and $Y_1 = a + bX$,

$$P = X - (a + bX)$$
$$= X(1 - b) - a$$

in which X = estimated sales
a = constant total costs
b = variable total costs ÷ corresponding sales
P = profit

The sales required to yield a given profit (P) for a particular business are

$$X = \frac{P + a}{1 - b}$$

EXAMPLE: A certain business operates with Constant Total Costs of \$350,000 per annum, and the ratio of Variable Total Costs to Corresponding Sales is 0.35; what are the estimated profits for sales of \$600,000?

Solution:

$$P = \$600,000\,(1 - 0.35) - \$350,000$$

$$= \$40,000$$

What sales are required in order to realize a profit of \$80,000?

The sales must be $X = \dfrac{\$80,000 + \$350,000}{1 - 0.35} = \$661,538.$

The business will break even at sales of

$$X = \frac{a}{1-b} = \frac{350,000}{0.65} = \$538,460$$

The Law of Unit Cost. When the products of manufacture may be expressed in some unit such as pounds, as is the case with granulated sugar or iron castings and similar products; or the number of automobiles of a standard size and type, it is useful to know the cost per unit of product at different rates of production. This may be determined as follows:

Let N = number of units produced in a given time period
a = Constant Total Costs during the same time period
X = sales in dollars, during the same time period
b = Variable Total Costs ÷ Corresponding Sales
S = unit selling price
C = unit cost

Then the total costs of the business during the time when N units of product are made and sold is:

$$Y_1 = a + bX$$

$C = \dfrac{Y_1}{N} = \dfrac{a}{N} + \dfrac{bX}{N}$, also $X = NS$; therefore

$$C = \frac{aS}{X} + bS$$

$$= S\left(\frac{a}{X} + b\right)$$

EXAMPLE: A product sells for 20 cents per lb. The Constant Total Costs per annum are \$250,000 and b is 0.4. What is the unit cost when the sales are \$500,000 per annum?

Solution:

$$C = \left(\frac{250,000}{500,000} \times 0.20\right) + \left(0.4 \times 0.20\right)$$
$$= \$0.18$$

EXAMPLE: If the maximum capacity of the plant is 4,000,000 lb per annum, what is the unit cost at maximum capacity?

Solution: The sales value per annum at maximum capacity is \$4,000,000 × 0.20 = \$800,000. Accordingly,

$$C = \left(\frac{250,000}{800,000} \times 0.20\right) + \left(0.4 \times 0.20\right)$$
$$= \$0.0625 + 0.08$$
$$= \$0.14\tfrac{1}{4} \text{ per lb.}$$

The Law of Factory Expense. If factory expense is expressed as a percentage of the direct labor cost, it will be found that this percentage will vary with the rate of production. Factory expense, like Total Costs, is made up of certain costs which are constant and others which are variable.

Let f = constant factory expense for a given period of time (dollars)

$z = \dfrac{\text{variable factory expense}}{\text{corresponding output}}$

$l = \dfrac{\text{direct labor cost}}{\text{corresponding output}}$

x = output for a given period of time (dollars)

t = total factory expense for a given period of time (dollars)

$p = \dfrac{\text{total factory expense}}{\text{total direct labor}}$

Then $t = f + zx$ and $p = \dfrac{t}{lx} = \dfrac{f + zx}{lx} = \dfrac{1}{l}\left(\dfrac{f}{x} + z\right)$

EXAMPLE: A manufacturing plant operates with a constant factory expense of \$150,000 per annum. The accounts also

show that when sales are $1,000,000 per annum, the direct labor cost is $500,000 and the variable factory expense is $60,000. What is the ratio of factory expense to direct labor cost when sales are $500,000 and $1,000,000 per annum, respectively?

Solution:

$$f = \$150,000$$

$$z = \frac{60,000}{1,000,000} = 0.06$$

$$l = \frac{300,000}{1,000,000} = 0.3$$

For $500,000 annual sales,

$$p = \frac{1}{0.3}\left(\frac{150,000}{500,000} + 0.06\right)$$
$$= 1.20$$
$$= 120 \text{ per cent of direct labor cost}$$

For $1,000,000 annual sales,

$$p = \frac{1}{0.3}\left(\frac{150,000}{1,000,000} + 0.06\right)$$
$$= 0.70$$
$$= 70 \text{ per cent of direct labor cost}$$

V—DETERMINING THE EFFECTS OF REORGANIZATION AND CHANGES OF POLICY

Very frequently a company finds it necessary to change its methods of manufacture or merchandizing or both in order to meet new economic conditions. Sometimes it is found desirable to modernize the plant by installing new machinery and new methods of manufacture as a means of lowering the costs of manufacture. Any changes of this character will alter the economic characteristics of the business, and it is therefore desirable to disclose the economic effects of such changes by the use of the break-even chart.

Let us assume, for example, that a certain manufacturing business has the economic characteristics shown by the solid lines of the break-even chart in Fig. 6. The management decides to install new machinery and mechanize the plant. It is estimated that by so doing the Constant Total Costs of the business will be increased from $500,000 annually to $800,000, due primarily to increased interest charges, depreciation, and other items. It is also estimated that the Variable Total Costs, which are $1,700,000 annually at 100 per cent capacity, will now be reduced to $1,080,000, due to reductions in labor costs and other operating expenses. The effect of these changes may be shown by plotting a new break-even chart, shown in broken lines in Fig. 6. It is found that the business may now be expected to break even at 60 per cent of original capacity instead of 70 per cent as formerly, and that the profits at 100 per cent of original capacity are estimated to be $520,000 instead of $200,000, or 160 per cent greater. These changes are expressed in terms of the original capacity, for in all probability the total capacity will also be increased when these changes are made. The example chosen for illustration happens to work out satisfactorily, and indicates that the suggested changes in methods of manufacture are desirable. It is not to be assumed, however, that such will be the case in all instances, for sometimes it is found that the break-even point is raised instead of lowered, even though there may be a slight increase in profits indicated at 100 per cent original capacity. Under such circumstances it must be decided whether or not the probabilities for increased sales will justify the change. If sales decline sufficiently the company may have a loss where formerly it made a profit.

Those industries which in prosperous periods have mechanized their plants and substituted the higher fixed charges of the machine for the variable cost of labor have found themselves at a disadvantage during the depression period, because of the higher costs per unit of product when the rate of production

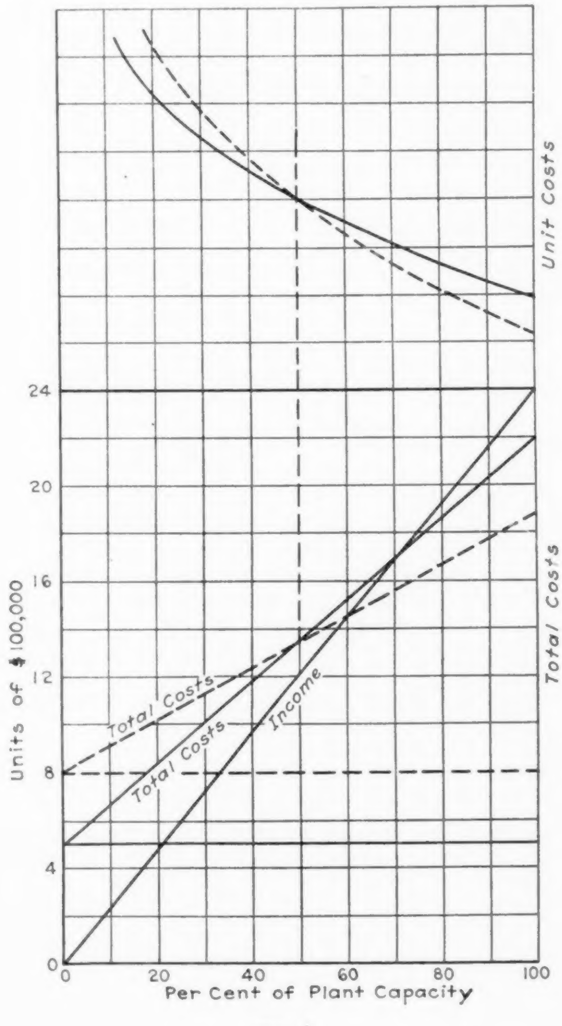


FIG. 6

is low. This situation is indicated by the upper portion of Fig. 6, which shows the costs per unit of product in the two cases. So long as the business is operated above 50 per cent capacity, the mechanized plant can produce at lower unit costs. Below 50 per cent capacity, the original kind of plant has the advantage.

VI—COMPARISON OF TWO DIFFERENT BUSINESSES

The difference between two businesses with respect to the probability of earnings over a wide range of sales may be shown by the use of these charts, although their profit-and-loss statements upon superficial examination may indicate that both businesses have about the same earning capacity. A certain company, let us call it Company A, shows annual sales of $2,000,000 and net profits of 15 per cent on sales, or $300,000.

The profit-and-loss statement of Company B which manufactures and merchandizes a wholly different product also shows annual sales of $2,000,000 and net profits of 15 per cent on sales, or $300,000. It is important to note, however, that the profits as percentages on invested capital are different. Both companies are operated at full capacity. An examination of the Constant Total Costs and Variable Total Costs shows the following:

	Company A	Company B
Constant total costs..........	$ 700,000	$ 200,000
Variable total costs..........	1,000,000	1,500,000
Total..................	$1,700,000	$1,700,000
Sales........................	2,000,000	2,000,000
Net profit...............	$ 300,000	$ 300,000

Upon constructing the break-even charts for each company, and superimposing them, we find some important differences in their earning characteristics.

These charts are shown in Fig. 7. The one constructed with solid lines if for Company A and the one with broken lines is for Company B. Both companies earn the same total profit when operated at full capacity. Company A breaks even at 70 per cent, while Company B breaks even at 40 per cent capacity. Accordingly, Company B makes a profit over a wider range of sales. It has more elasticity. It can be operated at a profit of approximately $140,000 when Company A shows no profit for the same volume of sales. Company B breaks even when Company A shows a loss of $300,000. Company B is typical of those industries in which there is little plant investment and consequently the fixed charges are low. The principal costs are for materials and labor. Company A, on the contrary, represents those businesses in which the fixed charges or Constant Total Costs are high, such as highly mechanized industries. The management of Company B can discharge its help as sales decline, but that of Company A finds itself in a wholly different situation in a declining market, and one in which it cannot readily help itself.

VII—INCREASE IN SALES REQUIRED TO JUSTIFY A GIVEN PLANT EXPANSION

The growth of business frequently raises the question of plant enlargement. On such occasions a prudent management will forecast the probabilities of profits and the shift in the range of sales in which a profit may be made. Plant enlargement results in an increase in fixed factory expense. There is more depreciation, more insurance and taxes, and increased maintenance and repairs and other charges. Let us assume, for example, that a certain manufacturing business is operated with Constant Total Costs of $550,000 per annum and that the ratio of Variable Total Costs to Corresponding Sales is 0.45. The business will break even at sales of $X = \$550{,}000/(1 - 0.45) = \$1{,}000{,}000$. If the sales value of the product at 100 per cent plant capacity is $1,500,000 the business would break even at 66²/₃ per cent capacity. The profit at 100 per cent capacity would be

$$P = X(1 - b) - a$$

where $X = \$1{,}500{,}000$
$b = 0.45$
$a = \$500{,}000$
$P = \$325{,}000.$

If the plant is enlarged 33¹/₃ per cent, the sales value of the products of the enlarged plant when run at full capacity would be $2,000,000. The Constant Total Costs would also be increased as above indicated. Assume this increase to be 20 per cent, giving Constant Total Costs for the enlarged business of $660,000. Assume b to be unchanged. The business will now break even at sales of $X = \$660{,}000/(1 - 0.45) = \$1{,}200{,}000$. In order to make a profit of $325,000 as before when the plant was run at full capacity and sales were $1,500,000, it is found that the sales must now be equal to

$$X = \frac{P + a}{1 - b}$$

$$= \frac{\$325{,}000 + \$660{,}000}{1 - 0.45}$$

$$= \$1{,}790{,}909$$

Accordingly, there must be at least $290,000 increase in business to justify the plant expansion. When the enlarged plant

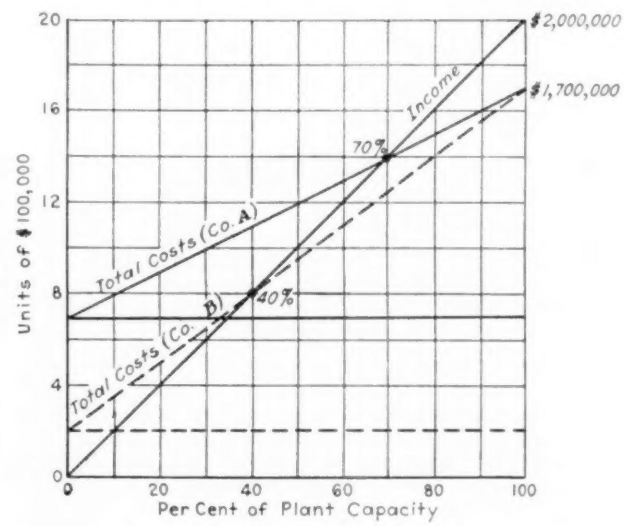


FIG. 7

is operated at full capacity, that is, when sales are $2,000,000, the profit will be

$$P = \$2{,}000{,}000\ (1 - 0.45) - \$660{,}000$$
$$= \$440{,}000$$

If, however, the increased business should not be realized, and maximum sales were $1,500,000, the profit would be

$$P = \$1{,}500{,}000\ (1 - 0.45) - \$660{,}000$$
$$= \$215{,}000$$

which is $110,000 less than before the plant was enlarged. And if sales should decline to $1,000,000 annually, the business instead of breaking even would suffer a loss of

$$P = \$1{,}000{,}000\ (1 - 0.45) - \$660{,}000$$
$$= -\ \$110{,}000$$

Question: If the break-even point of a business is 75 per cent of plant capacity, is there a hazard in having a single customer take 30 per cent of the output? If you were the customer, and knew that you were taking 30 per cent of the manufacturer's output, would you press him for a price reduction?

VIII—INCREASE IN SALES REQUIRED TO BALANCE A GIVEN REDUCTION IN SELLING PRICE

The purpose of price reduction is usually to hold the market

against competitors or to increase volume of sales through offering more attractive prices than competitors. It also makes the product available to purchasers in the lower-income classes. The pricing of the product is a problem continually facing the manufacturer. The sales department as a rule is asking for lower prices because it reduces sales resistance. When price reductions are considered, the manufacturer is confronted with a number of problems. He may well ask himself: How much more sales must be made to make the same profit? At what volume of sales will the business break even at the lower selling price? Can he answer these questions intelligently if he does not know the economic characteristics of his business?

Let us assume, for example, that a manufacturer is confronted with the suggestion that prices be cut 10 per cent on the theory that it will stimulate sales and furthermore will bring his prices in line with those of competing products. The Constant Total Costs of the business are \$250,000 per annum and b is 0.40. The sales at present prices are \$500,000 per annum and the profit is

$$P = X(1 - b) - a$$
$$= (\$500{,}000 \times 0.60) - \$250{,}000$$
$$= \$50{,}000$$

What must the sales be if the same profit is to be made? The ratio of Variable Total Costs to Corresponding Sales on the basis of present prices is $b = 0.40$. If prices are reduced 10 per cent, then b becomes $0.4 \div 0.9 = 0.444$. Then the sales required to yield a profit of \$50,000 must be

$$X = \frac{P + a}{1 - b}$$
$$= \frac{\$50{,}000 + \$250{,}000}{1 - 0.444}$$
$$= \$530{,}000 \text{ approx., or 6 per cent above present volume}$$

If sales are not increased, the profit will be reduced to

$$P = (\$500{,}000 \times 0.566) - \$250{,}000$$
$$= \$33{,}000, \text{ or a reduction of 34 per cent}$$

Accordingly, if the 10 per cent price reduction suggested is to be justifiable, there must be more than a reasonable probability of a sales increase of over 6 per cent, and this probability must be weighed against the risk of a reduction in profits of 34 per cent if sales are not increased after prices are lowered.

IX—EFFECT OF A CHANGE IN WAGES OR MATERIALS COST ON PROFITS

If an increase in wages is granted or an increase in cost of materials must be met, the manufacturer is confronted with problems somewhat similar to those of price reduction. Let us assume that in the above case the direct labor cost is 50 per cent of the Variable Total Costs, materials costs are 40 per cent, and other variable costs are 10 per cent. If a 10 per cent increase in direct-labor wages is to be granted, what increase in sales is required to balance it, that is, to earn the same profit as before? When direct-labor wages are increased 10 per cent there will be an increase of 5 per cent (10 per cent of 50 per cent) in the Variable Total Costs, and hence b will be increased 5 per cent or have a value of 0.42. The sales required for the same profit (\$50,000) are

$$X = \frac{\$50{,}000 + \$250{,}000}{1 - 0.42}$$
$$= \$517{,}240, \text{ or approximately } 3^1/_2 \text{ per cent increase}$$

X—WHEN SALES AND PLANT OUTPUT ARE NOT BALANCED

It rarely happens in any manufacturing business that the volume of sales for any month exactly equals or balances the production for that month. This balance is very close in industries manufacturing perishable products such as bread, yeast, and similar food products. In industries such as the beet sugar and fertilizer, which are seasonal in manufacture, the product manufactured in a given month may be sold many months later. Accordingly, recognition must be given to this fact in estimating profits for any particular month through the use of the break-even chart.

XI—A BREAK-EVEN CHART FOR EACH PRODUCT MANUFACTURED

The majority of manufacturing businesses are engaged in producing several different units of product. An electric manufacturing company may produce motors, control devices, switchboards, lamps, and other products. It is very difficult in such cases to visualize the operations of the business, and particularly to know the extent to which each group of products is contributing to profits or incurring losses. It happens not infrequently that some products are occasioning losses which are not revealed, and although while the business as a whole may be profitable, the profits would be even greater if the unprofitable lines were eliminated. Sometimes businesses operating at a loss have been made profitable by the elimination of those classes of products which have been causing the loss. It is not always a simple matter to find the items which are unprofitable either to manufacture or to merchandize, because the relations between cause and effect in matters of cost are not always apparent.

It is of great assistance to determine the economic characteristics of each group of products manufactured and to deal with each as if it were a separate business enterprise. To do this, it becomes necessary, after having determined the economic characteristics of the business as a whole, to reexamine the data and assign to each group of products its fair proportion of factory expense and general expense, both constant and variable. The basis of such apportionment is not always apparent and must be devised by the use of good judgment. No general rules can be given for this procedure, because the cost factors of industrial processes vary greatly and one industry differs from another quite markedly in this respect. Although the apportionments made may not be absolutely correct, they are at least indicative, if not conclusive. Furthermore, after some experience with the use of break-even charts for each group of products manufactured, certain improvements in their construction leading to closer approximations to the truth will be gained.

EXAMPLE: A certain company was engaged in the manufacture of five principal groups of products which we shall designate as A, B, C, D, and E. An examination of past sales and trends indicated that for the next year these products should be sold as follows:

Product	Annual sales	Per cent
A	\$2,000,000	$33^1/_3$
B	520,000	$8^2/_3$
C	2,520,000	42
D	480,000	8
E	480,000	8
Total	\$6,000,000	100

The Constant Total Costs for the business as a whole were estimated to be $2,250,000 and the Variable Total Costs for sales of $6,000,000 were estimated to be $3,000,000. Upon examining the constant total and variable total cost items it was estimated that each group of products contributed to these in the following proportions:

Product	Per cent of constant total costs	Per cent of variable total costs
A	40	30
B	10	5
C	35	50
D	8	10
E	7	5
Total	100	100

From these data (which are taken from the records of a prominent manufacturer) it was possible to construct a break-even chart for each product manufactured, and therefore to deal intelligently with the economic problems associated with the manufacture and sale of each kind of product. Among other important information which such an analysis disclosed, was the volume of sales per week which must be accomplished with each product in order to break even. In this case it was found that the break-even weekly sales were as given in the following table.

Product	Break-even sales (weekly)
A	$31,400
B	6,100
C	37,800
D	9,100
E	4,850

XII—CHANGING THE BREAK-EVEN CHART

It must be remembered always that business is in a state of flux. Conditions today are not the same as yesterday. Prices obtaining in 1929 for both materials and labor are much higher than those of 1932. New methods of manufacture are constantly being introduced in progressive businesses. Products are redesigned to improve their functions or to reduce their costs of manufacture. Changes in management procedure are made from time to time. A self-satisfied management may permit inefficiencies to creep in, with resulting increases in costs of management or processing or both. Markets vary, and style changes occur from time to time. Women wear short skirts and the textile business is not so good; ribbons are not so popular and ribbon manufacturers are in difficulties. When the style changed from open cars to closed cars, the celluloid business was not so good, because fewer side curtains were in demand. And thus we find in never-ending review a continuous series of changes in the habits of the consumer. Quantity and quality demands, costs of manufacture, costs of merchandizing, the relation between constant costs and variable costs, both total and unit, the relation between factory expense and labor cost or productive hours, are not constant for any business. They may not change much for a given period of time, but they do change. Accordingly, a break-even chart, unit-cost curves, and profit analyses should be made periodically and compared with the results of operations. They should be made at least annually for every business, and in many cases an analysis every six months will be found profitable.

XIII—REDUCING THE OVERHEAD IN TIMES OF DECLINING SALES

We shall endeavor at this time to construct a graphic chart of the economic characteristics (break-even chart) with a different arrangement of the items of cost from that set up previously in the hope of showing more clearly the relationships which bear on the problem of expense control.

It was noted previously that the Constant Total Costs of doing business are composed of two groups of costs, namely, those which arise from the inherent characteristics of the business and are fixed with respect to time, and those which arise from decisions made about running the business. The items of the first group are insurance, taxes, interest, and depreciation. In a sense, of course, the amount of insurance charges can be controlled within certain limits, the interest charges are subject to some variation as to amount and rate, and the depreciation may be altered by executive action. With due regard, however, to those particulars, this group tends to remain at a fixed level of cost during a given time period. We shall designate this group as a_1.

The materials (direct materials) cost per unit of product remains the same for a given unit price of materials when we disregard the slight variations in unit price arising from quantity purchases and from the discounting of bills payable. Accordingly, the Variable Total Costs of materials will vary directly with the volume of manufacture in a given time period and are not subject to control by the company, except of course through the redesign of product and substitutions of different-priced materials that are made. We shall designate the total cost of direct materials for a given quantity of production by v_m.

If now we construct the constant-total-cost line a_1 and the variable-total-cost line arising from v_m as in Fig. 8, we define a line of total costs t-t which is in effect a base total cost below which we cannot go or which cannot be lowered for the particular business under review.

The second group of Constant Total Costs, which will be designated a_2, arise from decisions made about running the business. Some of these decisions may not be changed materially, while others may. If, for example, it has been the practice to carry a certain staff on the payroll for the purpose of operating a particular service as part of a plan of management and it is decided to change the plan of management so that the service in question is no longer provided, then such a decision will effect a lowering of the amount of a_2. On the other hand, if the plant is to be run at all, certain key men such as a works manager, chief accountant, chief storekeeper, and others who render different services must be kept on the payroll, even though at a reduced salary or wage. The value of a_2, therefore, may be changed, but will be constant as determined by particular policies. The line may now be drawn in the chart, parallel to t-t and at a vertical distance of a_2 to scale above it. This line is drawn as the broken line w-w in Fig. 8.

The next group of Variable Total Costs to be considered are those which arise from the use of indirect materials and indirect labor in the factory, from the payment of commissions on sales, and because of other services. The amounts of such costs, while varying directly with the volume of output and sales, are nevertheless to some extent controllable by the management. The relation of these costs to output may now be included in the chart by the construction of the line w-y which is so laid out that the distance w to y will be equal (to scale) to the amount of such costs when the plant is run at 100 per cent capacity for one month. There remains now the Variable Total Cost due to direct labor which is termed v_l in this analysis. The line showing these costs is the line y-z in Fig. 8, and is constructed so that the distance y to z shall equal (to scale) the direct-labor cost when the plant is run at 100 per cent capacity for one month. By construction,

the line w-z is the terminal of the ordinates which measure from the base the total costs incurred at varying outputs per month. If now the sales value of the products manufactured during the month when the plant is run at 100 per cent capacity throughout that period is located at S and a line O-S is drawn, the ordinates to this line represent the sales values of the units produced at the corresponding capacities or outputs. The point of vanishing profits or the break-even point is at x. The profit p for a given volume of output is determined by the selling price and the total costs. For a given selling price, therefore, the amount of the profit for a given output is determined by the ordinate to the total-cost line w-x-z or upon C_t (the total cost) which is equal to $v_l + v + a_2 + v_m + a_1$.

The construction of this chart is based on certain assumptions which we shall now review. In the first place, the assumption was made that a portion of the constant total costs (a_1) incurred during a given time period (in the case of the chart under review the time is one month) is independent of the volume of goods produced during the month. It is obvious that this assumption is correct.

In the next place, it was assumed that the material which entered into the product at a given unit cost gave rise to a total

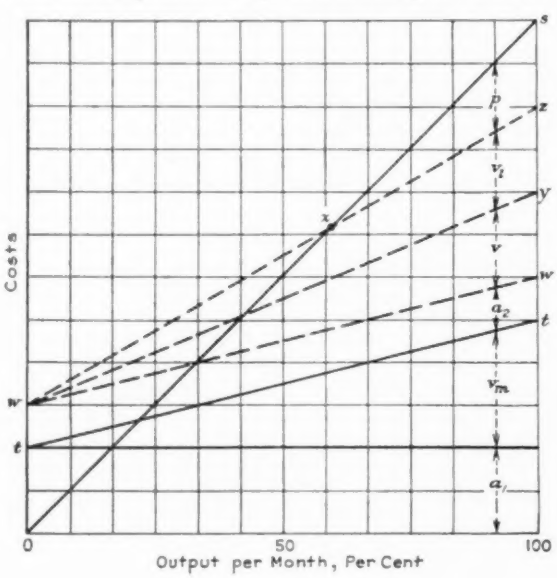


FIG. 8

cost of materials for a given volume of production in direct proportion to the quantity of goods produced. This obviously is also a correct assumption. The final assumption was that the sum of the total labor cost (v_l) and the service costs (a_2 and v) for a given quantity of goods produced and sold will be directly proportional to the quantity of output. This is the same as the assumption that a given labor cost together with a given service cost will always result in the production and sale of a given quantity or the same quantity of goods in a given shop. From our observation of the results of business operations we know that this assumption is not strictly correct, and that the degree of departure in any given case will depend on certain conditions which we shall now examine. The act of production in its essential elements consists of the functioning of two forces, and these are equipment and service, including the service of direct labor.

The act of merchandizing also results from the functioning of two forces, and these are (1) the equipment, such as warehouses and display rooms, and (2) the services of salesmen, supported by the service of advertising, transportation, etc. These two acts (production and merchandizing) are coordinated and supported by the services of administration.

When a business is operating at a uniform rate of production and sales, all the forces which are in action tend to adjust themselves to given levels of cost and to continue at these cost levels until the equilibrium is disturbed. The primary cause of change is variation in sales demand. With a constant sales demand and rate of production the controllable cost factors a_2, v, and v_l tend to stand at fairly constant levels. A change in the rate of demand, either above or below the existing rate, may not always meet with a corresponding change in the rate of production. If the history of the business shows that there are certain seasonal demands, the company may adopt the policy of not adjusting production to these seasonal variations, but to manufacture at a uniform average rate.

Even under these circumstances there is always a certain amount of elasticity evident in manufacturing operations. If a slight increase in production is demanded, labor will usually respond with a greater output, and those who assist labor with various services also respond in like manner. A slight decrease in the demand for products usually finds a corresponding response, with the result that with the same total cost of labor and other services there is a lessening of production. The management is usually not sensitive to small changes in the rate of production, and consequently while the total costs (a_2, v and v_l) remain the same, a_1 obviously being unchanged but v_m changing directly with output, the output will vary, and hence the total cost line w-x-z will consist of a series of steps. If, however, the change in demand is not seasonal but tends to be of long duration, such as the decline in sales now being experienced as a result of the depression, then an adjustment of the production rate of considerable amount is imperative. With the lowering of the rate of production there is also a demand to reduce expenses, and, as stated above, the point of attack is usually the overhead. Now the real problem to be solved is not the reduction in overhead alone, nor the arbitrary discontinuance of certain services, but is in fact, as far as the production processes are concerned, the determination of what amount of direct labor and the proportionate amount of attending services are needed to manufacture the smaller quantity of goods, within a given time period, at the least possible cost. In the matter of sales the problem is to determine how much selling effort represented by salesmen and the attending services of advertising, etc., is essential to move a given volume of goods within a given time period. The problem, therefore, is not to reduce a_2 and v, which are the controllable items of overhead, but rather to establish a new a_2 and a new v *in proportion to* v_l. If the amounts of a_2 and v which are incurred in production are reduced too much, that is, if certain services are dispensed with to a greater extent than is warranted, it frequently happens that the services are not really dispensed with at all, but are simply shifted, usually to labor, and are performed at greater cost than before. In other words, to produce goods at a given rate under given conditions of equipment and management, there is not only required a certain amount of direct labor, but the labor must also be supported by a certain amount of *essential* service if it (the labor) is to be effectively employed. If this service is not rendered to labor then the work will be done less efficiently, which means that it will be done at greater cost. The problem of expense reduction cannot be solved effectively by a board of directors assembled in conference over a statement of costs and expenses and arbitrarily establishing certain reductions in overhead. The only rational means of expense reduction is to

determine the balance which should exist between v_l and the controllable overhead v and a_2 which will result in least cost for different volumes or rates of production, and then to establish means of control which will result in these proportions being maintained. If a chart of the economic characteristics has been prepared as the result of such analysis, then the proportions shown between v_l and $a_2 + v$ will be rational, and it becomes a problem of management to see that they are maintained. If, however, a chart of the economic characteristics of a business is based on data from conditions as found and these conditions are such that the services v and a_2 for a given value of labor are in excess of that which is absolutely essential—which all too frequently is the case, then a careful analysis may reveal some surprising possibilities for expense reduction.

These conditions not only relate to the production problem, but also to the question of merchandizing the product and to the services of administration. How much selling service in the way of advertising and display is essential to support X dollars of sales per salesman? How much administrative service is really necessary to the effective coordination of production and sales in all its aspects? How does the need for service to salesmen and for administration vary with different outputs and sales? Decisions in these matters also affect the values a_2 and v, because the expenses of these services are included in the controllable overhead. The economic characteristics which arise from the merchandizing and administrative policies do not admit of analysis as readily as those which are associated with the processes of production, because the relations between cause and effect are not so readily distinguished, much less measured. Overhead reduction in these matters cannot be made with the same degree of intelligence as is the case with the overhead associated with production. The practice of deferred maintenance is frequently resorted to in times of lower production, and is sometimes justified by the need of conserving resources at a time of declining profits or increasing losses. This practice, as the name implies, simply defers the expense of upkeep until a later date, at which it is hoped that the business will be more profitable. While this practice may tend to lower the break-even point at the time, it also tends to raise it in the future and also to occasion losses through more rapid depreciation of equipment which has been allowed to run into a bad state of repair.

XIV—INFLUENCE OF PLANT DESIGN ON THE ECONOMIC CHARACTERISTICS OF A BUSINESS

The extent to which the costs of producing goods at different rates of production can be regulated, is dependent on the extent to which the forces of production can be adjusted or controlled. If a plant is so designed that it is a large single-processing unit and that any production whatsoever from, say, 10 per cent capacity to 100 per cent capacity requires the running of the whole plant, the conditions of operation are as shown diagrammatically in Fig. 9.

This figure illustrates a plant in which the raw materials pass through a series of processes in succession, and the labor required to run the machines and the services supporting labor are practically the same, no matter what amount of material is being processed. Some types of bakeries, sugar mills, and cement plants are designed along these lines. Because of the very nature of the design, such plants require about the same amount of labor and services when running light as when running to full capacity, and therefore their economic characteristics show little change in the controllable costs a_2, v, and v_l for different rates of output. At the other extreme of plant design are such plants as those typified by certain forge shops in which there are a group of complete producing units. Fig. 10 shows a design of this kind. In a forge shop, machine No. 1 would represent a heating furnace and machine No. 2 a hammer. Each group of units is capable of converting raw materials into finished products. Accordingly, with a decline in demand from 100 per cent capacity to, say, 75 or 70 per cent capacity, one of the groups of units may be shut down and the attending labor and *certain* services such as the indirect labor needed to handle materials at one group and the power to operate a group may be dispensed with. When the demand falls under 50 per cent another group of units may be shut down, with still further reductions in the cost of labor and some services. Therefore a plant designed according to these principles of operation permits a considerable variation of the controllable costs a_2, v, and v_l, and the economic characteristics as shown by a break-even chart will be quite different from those for a plant of the type first described, particularly in showing

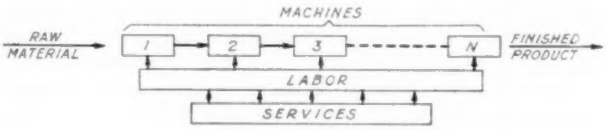


FIG. 9

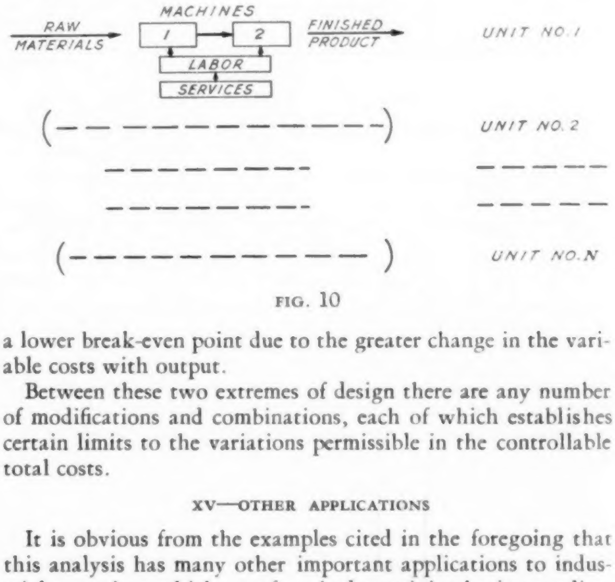


FIG. 10

a lower break-even point due to the greater change in the variable costs with output.

Between these two extremes of design there are any number of modifications and combinations, each of which establishes certain limits to the variations permissible in the controllable total costs.

XV—OTHER APPLICATIONS

It is obvious from the examples cited in the foregoing that this analysis has many other important applications to industrial operations which are of use in determining business policy, but which the limits of this paper will not permit being reviewed. In the field of banking and finance, for example, such analyses are important in judging credit risks, and for determining the economic consequences due to changes in the financial structure.

In the search for a procedure by which the hazards of business ventures may be reduced, it is believed that an extended application of the foregoing methods of analysis should receive serious consideration. Not only does this apply to individual companies, but also to whole industries. With such analyses in general use by manufacturers and bankers and by group associations for whole industries, together with the studies of economists on the trends of prices and volumes of trade as affecting particular industries and business units, much could be accomplished toward the elimination of the element of surprise in business and the stabilization of our economic processes.

SURPLUS POWER *from* INDUSTRIAL PLANTS

Its Greater Utilization by Public-Utility Systems

By A. G. CHRISTIE[1]

MANY industries have at times potential energy which might be used either in their present equipment or in new units, to develop power in excess of that which they individually require. The utilization of such power by public-utility systems has presented problems and difficulties to both industrial and utility executives, which difficulties in many cases have prevented its use. Some considerations involved in this utilization will be outlined in the following paragraphs, and suggestions will be presented that may lead to a greater development of such surplus power.

THE COST OF SURPLUS POWER

The energy which an industrial plant may at times have in excess of its particular requirements, is here considered as "surplus power." Industrial processes often require much heat in the form of steam at comparatively low pressures. Electrical energy may be generated cheaply by installing boilers for much higher steam pressures and temperatures than process conditions call for, and by allowing the turbines to serve as reducing valves. Power thus generated requires the consumption of about 4500 Btu per kwhr, or, roughly, 0.33 lb of coal per kwhr. Frequently boilers can be fired with waste material of low economic value furnished by the industry itself.

Surplus power may consequently be produced at a low fuel cost. The other elements in total cost in the case of a new plant will be fixed charges on any additional turbo-generator plant and electrical or other equipment necessary, together with the additional fixed charges on the extra cost of high-pressure boiler plant and piping over low-pressure equipment. To the total of these charges must be added operating and maintenance costs on additional turbo-generator and electrical plant, and any additional maintenance costs that the high-pressure boiler plant may require. If the generating voltage and frequency of the industrial plant are not such that the current can be delivered directly into the utility's distribution system, the necessary transformers, frequency changers, and switching may require considerable additional investment, on which fixed charges must be earned.

When the industrial plant already has high-pressure boilers and turbines, but the latter do not at all times provide sufficient process steam for factory requirements due to low power demands at the moment, surplus power could be generated at these random times by passing all steam through the turbines, provided that this power could be marketed, and that the turbines are of sufficient capacity. The only cost of this power with boilers and turbines already available would be the fuel cost of 0.33 lb of coal per kwhr and certain incremental charges for additional labor and maintenance. This is about the cheapest steam-generated power that may be available.

However, industries generally limit generator capacity to their own power needs. Any additional capacity to use all the steam required by an industry may involve extra investment on which fixed charges must be paid, thereby increasing the cost of the surplus power.

There are frequently periods of the year when an industrial concern could save money by shutting down its plant and taking power from the utility, as, for instance, in summer time in some northern plants that have a large space-heating load. Utility loads are lightest during the summer period, and the industry could be readily served by the utility. In winter the industrial plant may have surplus power to deliver to the utility when the load on the utility's system is highest. These generalizations suggest mutual advantages in a power interchange.

The drafting of satisfactory agreements for the delivery of surplus industrial power to the utilities or for the interchange of such power, is a difficult undertaking. Most utility executives are anxious to study and analyze every possible interconnection that may prove profitable to both parties. However, certain utility executives have been unfavorable to the idea of encouraging the development of surplus power or of power interchange. Some feel that their plants alone should supply all power needs, while a few hesitate to attack the rate problems that are involved in equitably adjusting charges for such service. Many industrial executives have been strongly opposed to any interconnection, regardless of the economics of the case. In consequence of these considerations, the utilization of surplus power by utilities has not progressed rapidly in America.

Conservationists will urge that this surplus power should be utilized in every possible case as it saves fuel resources. However, as noted above, other costs than fuel alone must be considered. The use of surplus power, either prime or secondary, by the utilities is only justifiable when its total cost is equal to or less than that of power available from other sources. This is the real crux of the problem, and an appraisal of surplus power can only be made when these costs are fully analyzed.

THE MARKET VALUE OF SURPLUS POWER

The utility secures its power supply by generating electricity either in its own plant or in that of a subsidiary company, or by purchase from other sources such as hydroelectric stations. The fixed charges of the utility are set by the investment in steam station or in hydro plant and any transmission system required outside the local distribution system. Costs, as far as labor, maintenance, and supplies are concerned, do not vary greatly in hydro plants with moderate changes in load, and these are the only operating costs involved. In steam plants, increased load requires the consumption of additional fuel, and some added labor. Fuel cost plus some labor and maintenance charges form the incremental cost to the utility for a small increase in steam-generated power. Charges for stand-by are unaltered or may even be reduced. Costs of "load prepared

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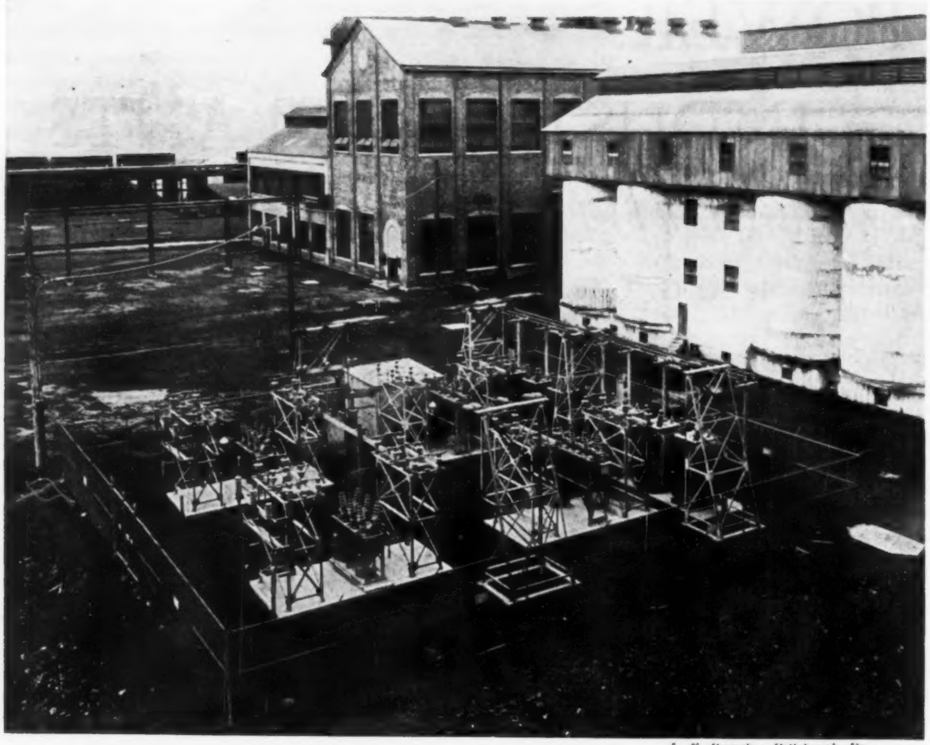


L. F. Beaudry, Pittsburgh, Pa.

VIEW OF SUBSTATION OF DAVISON COKE AND IRON COMPANY, NEVILLE ISLAND, WHICH HAS A PUBLIC-UTILITY INTERCONNECTION

for" would be practically unchanged by the addition of a small increment of load.

A supply of surplus power from an industrial plant to the utility's distribution network would save fuel and some labor and maintenance in the utility's steam plant, and in the case of a hydro storage plant would save water for use at other load periods as well as some line losses on the transmission line. Few hydro plants now operate without steam reserve stations. In the case of constant and adequate river flow, with no steam station in the system, water saved by a load decrease has no value. The utility cannot reduce its fixed charges on generating plant by any purchase of surplus power at random times, nor can it materially reduce the supervisory and operating force at its generating plant.

With present equipment and with the above considerations in mind, the utility could pay no more for surplus industrial power furnished at random times than the incremental cost of this block of power represented by additional fuel, operating labor, and maintenance in the steam station. In a system with hydroelectric plants, if one considers storage water as representing a fuel saving in the steam auxiliary station, the value of surplus industrial power would be the incremental fuel, labor, and maintenance charges in the steam station together with a portion of the transmission-line losses that are saved. These incremental costs are not difficult to estimate in a given system. In modern systems, incremental fuel costs will be comparatively low since the fuel consumption in the newer stations ranges from 1 to 2 lb of coal per kwhr. On these bases alone the utility can only pay low prices for surplus power furnished at odd times.

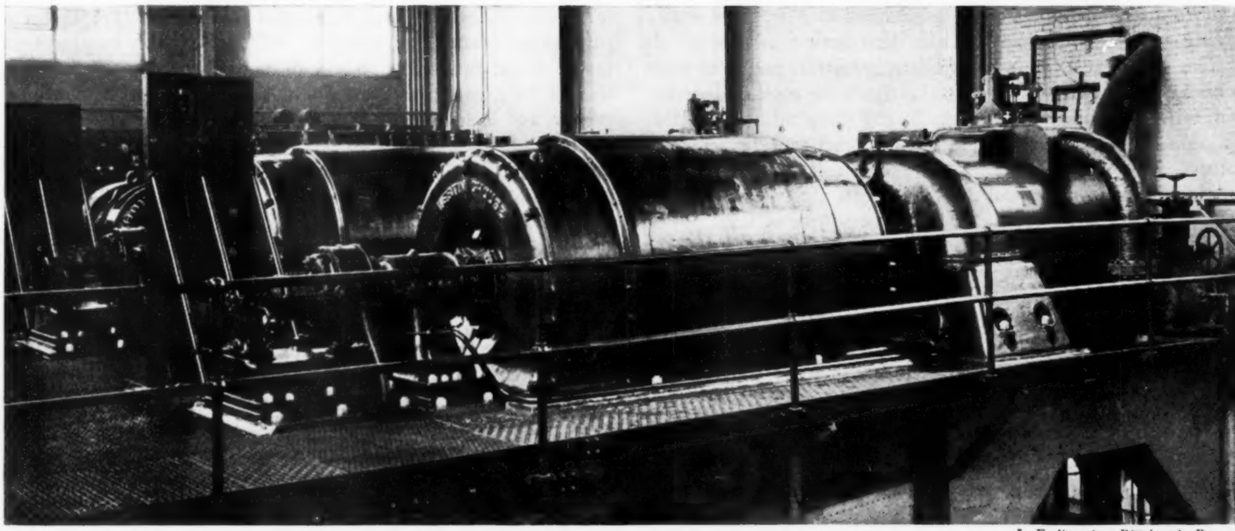
These low prices based on the utility's incremental costs, may or may not be profitable to the producer of the surplus power. If no additional steam or electric generating plant is necessary to produce the surplus power, the industrial plant may be able to make money by selling its surplus even at these low rates. This is particularly true where the industrial plant's fuel has little or no sales value. On the other hand, if fixed charges must be included on new turbo-generator and electrical equipment and on the extra cost of new high-pressure boilers over low-pressure units, it is probable that the service can only be profitable to the industry if the annual load factor of such surplus output is unusually high and the fuel costs little or nothing.

In some cases it has been proposed that the utility build a high-pressure power plant adjacent to the industry, which plant will burn all the industry's waste fuel, paying a nominal rate therefor. Several of these plants are in operation. Such a plant could furnish the industry with process and low-pressure steam and with its electrical requirements at certain rates. Any surplus electrical power thus generated goes to the utility. The rates for steam and electric power to the industry should be about equal to what it would cost the industry to generate its own power. Stated in other words, these rates must include practically the whole of the fixed and operating charges on that portion of the plant which is represented by the industry's demand. If the plant capacity does not exceed this amount, then the surplus power can be had by the utility for its incremental fuel and other charges. Should additional waste fuel be available, then bleeder turbines and condensers could be installed and the utility would bear all fixed and operating costs on that portion of the plant which produces this additional power.

From the standpoint of power rates based on the utility's incremental costs with present installed equipment, surplus industrial power at random times possesses small value and its sale may not prove profitable. Most of the propositions to utilize such power have been approached from this standpoint, and as a result there are comparatively few interconnections.

OTHER FACTORS IN POWER INTERCHANGE

However, there is another way of approaching the problem which may enable additional industries to market surplus power and the utility to utilize such power, at mutual profit. Certain industries in those locations where space-heating requirements are large and the heating season long, and certain central-station steam-heating systems, have large demands for steam from which surplus power may be secured during the winter season. This is the period of peak demand on most of the utilities. While heating peaks and power peaks seldom occur at the same hours, there may be a certain capacity of



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TURBINE FLOOR OF POWER PLANT OF DAVISON COKE AND IRON COMPANY, NEVILLE ISLAND, SHOWING TWO 6250-KW TURBINES

surplus power always available at the time of the utility's peak loads, and this capacity can be considered as "prime power." These amounts of prime power that could be connected to a large utility system may, in the aggregate, total to a considerable figure, particularly if some of the industrial plants are large. In a growing system this total prime-power capacity in the industrial plants can take the place of equivalent added capacity in the utility's power plant and thus lessen central-station investment. The utility could therefore pay for such surplus power a figure equivalent to the incremental cost, considering fixed charges, fuel, and operating and maintenance expenses, of the same additional new capacity if installed in one of its own plants, provided the industrial plant will undertake to furnish this prime power when needed by the utility whether or not the industry itself is in operation. Such a rate would be substantially higher than that discussed above, which includes no fixed-charge allowance to the industrial plant. Additional surplus power from the industrial plants over and above this prime-power rating which might be available at random hours of the day other than during the utility's peak load, could be paid for at the incremental cost to the utility of fuel, labor, and maintenance as discussed in a preceding section.

In the case that has just been discussed it has been assumed that the capacity of the central station is fixed by the winter load. There are cases of utilities which combine both steam and hydro power where the investment in steam stations is fixed, not by the winter peak load, but by the load during the extreme low-flow season, which usually occurs in late summer or early fall. The only capacity that could be considered as prime power in industrial plants interconnected to such systems would be that available during the peak-load hours of the low-water season.

Certain other considerations enter into the problem of interconnection of industrial plants and utilities. As the capacity of the industrial plant approaches that of individual units in the central stations of the utility, the interconnection between the two systems becomes more attractive to both parties. The cost per unit of capacity of the interconnection becomes lower with increasing load interchange. The large industrial plant can be built somewhat cheaper than the central station, for no more boiler or generating capacity need be installed than is necessary to meet the total steam demand of the industry, and large-capacity units may be used. Fuel, labor, and maintenance charges in large industrial-power stations approach similar costs in central stations.

Interconnections between utilities and small industrial plants often lead to unsatisfactory results owing to lack of mutual understanding and confidence. The utility frequently wishes to have some measure of control over the operators of the industrial plant in order to secure the maximum service from that source in such matters as the regulation of voltage and power factor. On the other hand, the utility operator often fails to appreciate the problems developed by the industry's own peculiar requirements. These difficulties can be removed by the instruction of each party on the other's problems, and by full appreciation of the fact that the maximum benefits and profits may be secured by both only from the most effective joint operation of the two systems. In other words, a spirit of mutual confidence and understanding must prevail.

RATES FOR INTERCHANGE POWER

The nature of the industrial demand, the time of this demand, whether or not stand-by service is required by the industry, and incremental generating rates at the utility's power plant, influence the matter of charges for power furnished by the utility to the industrial plant. In general these rates have had to be those approved by public-service commissions for power services, and frequently these are higher than warranted by the facts regarding the power interchange. Special rates will have to be established for power interchange by the utilities with industrial plants.

Assume that an industrial plant has surplus power from its heating load during the winter and desires to shut down or curtail its plant during the summer if power can be secured from the utility at an equitable rate. Since the utility has no peak loads in summer, it could render this seasonal service to the industrial plant at the incremental power cost for fuel and labor at its steam plant, plus distribution costs and profit. This cost to the industrial plant would be below the standard rates for power as no demand or stand-by charge is involved nor fixed charges on the central-station equipment. On the other hand, this rate for utility service to the industry must necessarily be considerably higher than that paid to the industry for its surplus power. The reason for this difference is apparent if the

utility's distribution system is considered as a separate entity serving as a "middleman" in the distribution of power. It receives power at a figure from other industrial plants or from its own power plant, and adds to this figure the costs of distribution, which include fixed charges on the distribution network, the costs of customer service, including meter rental, metering, billing, and collecting, the costs of power sales promotion, and a reasonable margin of profit. These costs must be distributed over all of the power sold, whether the source of such power is in the utility's own plants or whether the energy is bought from industries or others. When incremental costs of power at the generating station are involved, these distribution charges may be a significant item in the total cost.

From the standpoint of a "middleman," as far as distribution is concerned, the utility's price in selling or interchanging any power must include these distribution costs and profit, together with the production cost, whether incremental or otherwise. Hence it may be unfair in certain cases to expect a utility to exchange power with an industrial plant on a "kilowatt-for-a-kilowatt" basis.

Assume next that the demand for the utility's power is not seasonal but random. At one time the industrial plant will have surplus power available to the utility, at another it desires power from the utility. The surplus industrial power can be evaluated as above outlined, depending upon whether any portion is prime power or whether all must be offered at the utility's incremental rate. If the industry demands service during the utility's yearly peak load, then its requirements place it in the class of other power users. The industry should then pay the regular power rates for this service, which include the usual demand or readiness-to-serve charges. In this case the rates for utility service to the industry must greatly exceed the prices paid for the industry's surplus power.

However, the case may be quite different with intermittent power demands if the industry agrees to make no demand for power at the time of the yearly peak load or, in other cases, during the daily peak load. The industry may also agree to suspend the utility's service during certain contingencies. The industry contributes nothing to the total demand on the utility's plant, and in this case should be entitled, for any power furnished by the utility, to a rate based on the utility's incremental cost plus distribution costs and profit.

In all except the one case of demand at the time of the utility's annual peak load, the charges to the industry for power interchange require special rates rather than the regular charges for power. These should be based upon an engineering analysis of each case and should be fair and equitable to both parties. In too many instances rates have been based upon bargaining, and these have proved unsatisfactory to both parties.

THE VALUE OF RESERVE

The question arises whether the interconnection of an industrial plant and a utility affects reserve equipment. Few industrial plants carry reserve units. Relatively small industrial plants have little or no emergency value to the central station due partly to this lack of reserve capacity, but more to the frequent failure to provide the necessary teamwork in emergencies on the part of the average small-plant operator. Education may relieve the latter difficulty. An interconnection has some potential value to the industry as a possible reserve, although the industry may not have been accustomed to maintaining a reserve in its own plant. On the other hand, it is frequently possible that power-generating equipment not in use or needed by the industry at the time, might be called upon for emergency service by the utility. If this reserve in the industrial plants can be depended upon under all conditions and all times, as might be the case in large industrial plants, it will represent a substantial saving to the utility, which then does not have to invest in the equivalent reserve in its own plants. This factor should be given consideration in adjusting rates for surplus power, and in some cases is of considerable significance, for the utility should be willing to carry a certain portion of the fixed charges on that capacity of the industrial plant which thus serves as a reserve.

Rates for reserve and emergency demands on the part of the industry or the utility require special study and adjustment in each particular case. Aside from the demand cost that is based on the fixed charges of the reserve equipment, there are the added fuel, labor, and maintenance costs to be adjusted, and during emergencies these may be high. However, this problem is susceptible of analysis, and schedules of charges can be prepared which will prove satisfactory and profitable to both parties.

The question will be asked whether the utilization of surplus industrial power will result in lower rates to the utility's customers. This may not lead to any rate reduction of a substantial nature. As pointed out last year in a paper by the author before the Baltimore Section of the A.S.M.E. on "The Future Cost of Power" (see *Electrical World*, Jan. 9, 1932), other factors than the production cost of power have the greater influences in fixing rates for service. In the case of the domestic consumer, production cost at the power plant has little influence on his rate. The major influence affecting the domestic rate is the use factor developed by the consumer. The greater the hours of use of the connected load, the lower can be the domestic rate.

This whole discussion is presented because cases of available surplus power in industries are becoming numerous. In the past the industrial plant has suffered from poor engineering and indifferent executive control. Capable power engineers are now employed by the larger industries and are applying the same economical methods of power production that have made the plants of the public utilities a notable success. Diesel engines, high-pressure boilers, and bleeder turbines can be bought at low costs, and these inducements encourage the installation of industrial plants. With low fuel prices and labor wages, such industrial plants may produce surplus power at figures as low as, or lower than, the central stations. The necessary arrangements to profitably utilize the surplus power from such stations need the careful consideration of executives of both industries and the utilities.

CONCLUSIONS

The preceding paragraphs indicate that the costs of surplus industrial power to the utility should be based upon an incremental rate for similar power in the utility's stations, together with an allowance for fixed charges on all industrial plant capacity that can be considered as "prime power" and is available at the time of the annual peak load. Rates for power from the utility to the industry are affected by the nature of the demand, whether seasonal, off-peak, or instantaneous. The rate should be based upon incremental cost plus distribution charges and profits for all requirements not at the time of the annual peak. If power may be demanded of the utility at any moment, regular rates for power sales apply. The value of equipment in industrial plants for reserve to the utility should also be considered, as well as the reserve provided by the utility to the industry through interconnection. Finally, it should be possible for utilities to utilize more of this surplus industrial power than at present, and, on the basis of engineering analyses, to adjust the rates therefor so that they will be fair and equitable to both parties.

CREDIT CONTROL

Versus OVERINVESTMENT

An Unpremeditated Debate in Which Two Lively and Intelligent Engineers Disagree on Economic Matters—Or Do They?

By RALPH E. FLANDERS[1]

THERE are several theories as to business cycles in general, and more than that as to the particular one in whose nadir we are now disporting ourselves. Not all of these theories are mutually exclusive. Some of them may be secondary and others contributory. For instance, the effects of post-war deflation, international indebtedness, and agricultural overproduction are obvious, and one would hesitate to assign to them anything less than primary importance.

There is, however, a growing tendency for those seriously concerned to rally about one of three conspicuous banners, whose inscriptions read "Shorter Hours," "Credit Control," and "Down with Overinvestment," respectively. Not so very exciting, these battle cries, but they sum up the best thought of men whose sympathies have been stirred and whose minds are keen and active. The champion of shorter hours has already been introduced to readers of MECHANICAL ENGINEERING in the person of Mr. Arthur Dahlberg.[2] Now appears the champion of credit control in the person of Mr. Harwood,[3] while Mr. Coyle defends the overinvestment theory.[4]

Of the two, Mr. Coyle is the more lively and provocative. His language is picturesque, and his thrusts are carried to the extreme of his reach. He is looking for trouble and hoping to find it, particularly in the matter of arraying business and finance against each other.

While put in new and forceful terms, the opening of his argument will be familiar to many readers:

For the first century and more of its existence ours was a debtor nation, with undeveloped and needed natural resources, equipping itself for an expanding population. These conditions called for thrift, saving, and investment on a wholesale scale. Since the war we have become obviously a creditor nation with a population curve approaching an asymptote, whose developed resources are abundant beyond our power profitably to use. This new status is one of a surplus rather than a deficit economy. It carries the possibility of heightened consumption and such human values as may be drawn therefrom. It diminishes the uses of thrift and investment; and if we unduly persist in them, punishes us with an hypertrophied productive equipment whose output the consumer is unable to purchase. Too much has been saved and invested, too little is left for spending.

This position, as Mr. Coyle indicates, is practically that of the English writer Hobson, whose little book, "Rationalization and Unemployment," should be read for its sobering effect by every management engineer. To this argument another Englishman, J. M. Keynes, has cogently replied by pointing out in effect that expenditures for capital goods are as effective as those for consumer goods in keeping the wheels of industry turning. His dictum is that new investment must equal savings if a prosperous condition is to be maintained.

Hobson's and Coyle's reply is that there are limitations on profitable investment if the ratio between it and consumption gets overlarge. While there are a number of ramifications to this problem, it seems to the writer that the balance of the argument is on the side of Hobson and Coyle.

From this point forward Mr. Coyle enters on novel presentations of the problem. He sets up criteria of methods of control, applies them to various plans which have been proposed, and concludes that the effective remedy is to divert savings which are socially unnecessary and dangerous into social consumption of a valuable sort (what Dr. Harvey N. Davis would call "social investment") instead of into profit-seeking private investment.

THE BUSINESS CYCLE PRIMARILY ONE OF CREDIT EXPANSION AND CONTRACTION

The author analyzes the effects of this policy, concluding that it would be good for the consumer and good for business, but bad for the financier of the hitherto conventional type. He furthermore makes suggestions as to the specific provisions of such a tax to give it a maximum effectiveness.

His most ingenious contribution, however, seems to the writer to be in relation to the handlings of taxation

[1] Vice-President, Jones & Lamson Machine Co., Springfield, Vt. Mem. A.S.M.E.

[2] See review of his "Jobs, Machines and Capitalism," in MECHANICAL ENGINEERING, May, 1932, p. 317.

[3] "Cause and Control of the Business Cycle," by E. C. Harwood, M.C.E., Financial Publishing Co., New York, 164 pp., $2.

[4] "Business vs. Finance," by David Cushman Coyle, C.E. Published by Mortimer & Walling, Inc., New York, 1932; 44 pp., $0.60.

and social expenditure (or "public works") in such a way that these processes will have favorable secondary effects on credit expansion and contraction, and thus on another element in the business cycle. In so doing he leads up to this other theory that the cycle is one primarily of credit expansion and contraction, which some of us who have been following Hobson and Keynes have not sufficiently taken into account.

For there are other sources of purchasing power, whether for consumer goods, capital goods, or securities. These other sources lie in the various processes by which money and credit are expanded and contracted, inflated and deflated. In spite of the fact that Keynes in his work on "Money" devotes many chapters to this process, he seems to treat the volume of money as a fixed quantity when he comes to strike his balance between savings and investment, and others of us have done likewise. This elasticity of money has presented itself merely as an annoying interference with the steady progress of our argument.

Mr. Harwood rests his case solidly on the credit factor, and he does it in brilliant fashion. While founding his presentation on the necessity of balancing savings and investment, *a la* Keynes, he does not ascribe a wide imbalance between them to an excess or deficiency in one or the other, but rather to credit expansion as the effective agency in spreading them apart, and to contraction or deflation in bringing them together again.

AN INDEX OF INFLATION

Furthermore he has developed a statistical method for measuring the degree of difference, which he calls his "Index of Inflation;" and finally he presents a detailed record of articles published in *The Annalist*, *Barron's Weekly*, and elsewhere from March, 1928, up to the present time, which gave creditable predictions from this index of the actual subsequent course of events. The only unpublished statement submitted is one predicting wholesale bank failures in November, 1931, which the editor deleted because it was a bit too strong. It is comforting to note that he believes deflation to be approaching its stable base once more.

Roughly, his index is the ratio of investment-type assets to savings-type liabilities in the banking structure of the country as a whole. [Query: Are his values of investment-type assets their current market value in all cases, or have some of them been written up toward their "real value" as permitted by present practice of bank examiners?] His method of assembling these figures is carefully described, and the probable sources and degrees of error are noted.

While Mr. Harwood does not describe in detail the process of collapse, it is evident that the inflation-generated disparity between savings and investment—the buying of more than there is money to pay for—is a condition of unstable equilibrium, and any disturbing force may topple the structure over after the index has risen high enough.

Questions arise. Was there no way to restore equilibrium by increasing savings to give reality to the credit? Or is there no other way to sustain operations nearer the peak, which has never yet reached the physical possibilities of production, or the capacity of society for rational consumption? Why does the solid ground have to be so low down?

Now there is no question but that the index was a remarkably accurate indicator on the showing made by the author. But is it anything more? Does it relate to primary causes, or merely show results?

It should be observed at the outset that the history of the boom and collapse does not quite fit into the credit-theory frame. For instance, Mr. Harwood makes the usual references to a rise in the commodity price level as a phenomenon of the boom. But this did not occur in '28 and '29; he corrects himself by saying that the stationary level was a rise relative to the natural post-war deflation; and that the absolute rise was in security prices instead of in commodities. In another place he speaks of "the price inflation of capital goods as represented by securities," but the levels of these did not rise materially either, as far as cost of reproduction is concerned.

Again, he makes the common error of saying that numerous "businesses close their plants, at least partially, in preference to making the necessary price readjustments," when the practical business man knows that the plant must be run at all costs to reduce losses.[5] Finally, he omits to mention that this boom was unique in that no labor shortage appeared at the peak, and that it was a "buyers' market" throughout—evidences to the ordinary business man of failure of purchasing power.

SPECULATIVE FUNDS FURNISHED BY CREDIT EXPANSION

In the Progress Report of the American Engineering Council's Committee on Economic Balance, it was suggested that the cause of speculation (characterized by inflation) was the profitableness of existing plants combined with the evident absence of need for more, which directed funds into the purchase of existing securities rather than into plant expansion. This would explain the lack of inflation in commodity prices and its concentration on securities. But when we went on to argue that these speculative funds were withdrawn from purchasing power, we may have taken an untenable position. In a large measure they were furnished by credit expansion as Mr. Harwood describes. And Professor Cassel and others have shown with apparent finality that all speculative funds must appear as purchases of goods or services. Yet there is no increase in the volume of such transactions to match the increase in credit and speculative funds. The situation is not yet clear.

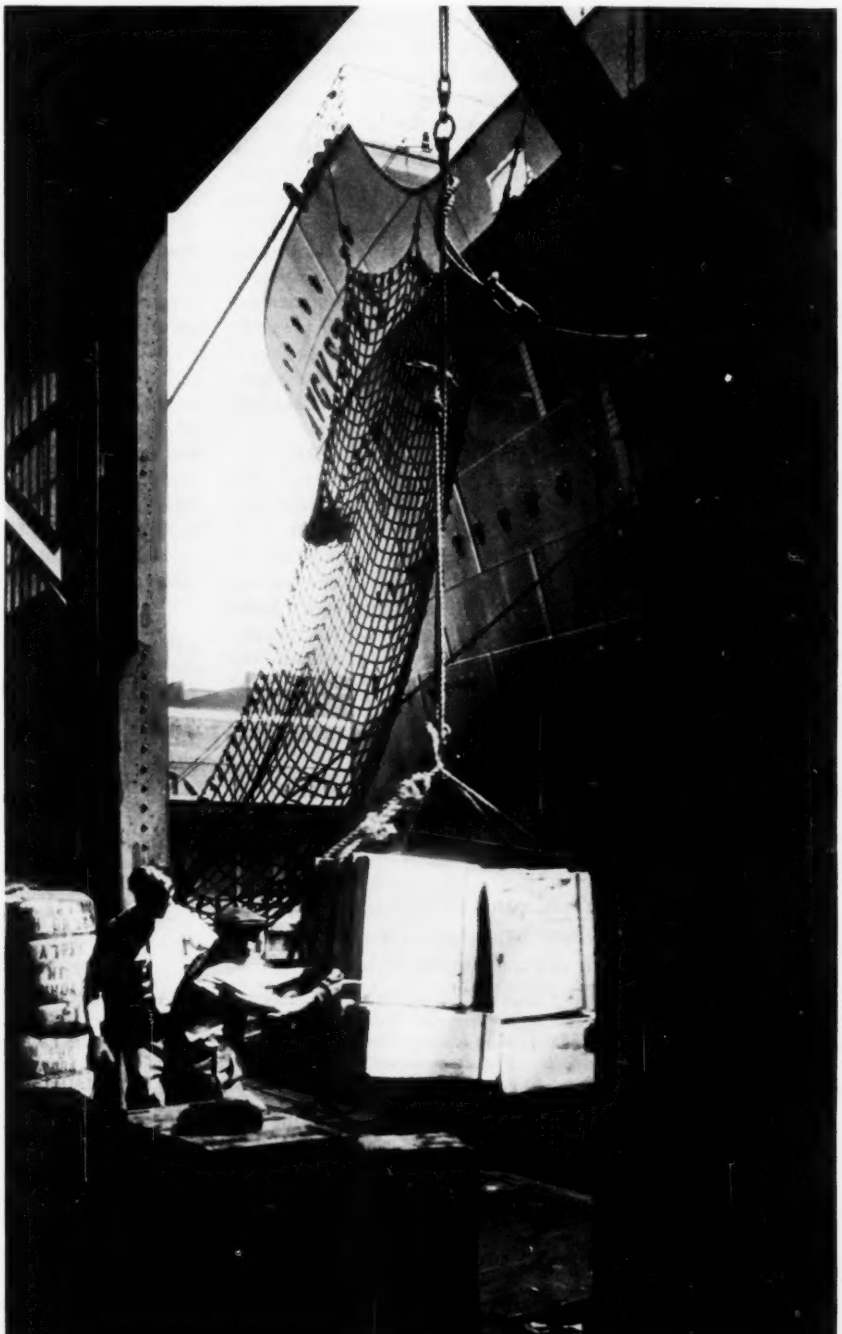
This much is plain: to the business man the problem presents itself as one of the distribution of the returns from industry, the flow of savings into investment, a general overequipment of industry, and a baffling failure in purchasing power to match a production by which it should theoretically be financed.

[5] See the writer's paper, "The Economics of Machine Production," in MECHANICAL ENGINEERING, September, 1932, p. 605.

To the expert who approaches the problem from the financial side the overequipment appears as an application of credit inflation rather than of savings, and the same explanation applies to the consumer credit which the manufacturer believes himself to be applying to make up for failing purchasing power.

The thing to do, evidently, is to get our two champions into personal combat, under some experienced but neutral referee, and let them come to terms with each other. Better yet, why should not Mr. Coyle and Mr. Harwood each approach the central problem sympathetically through the other's field of thought and experience, and then combine their findings? A book written by the two jointly, if it could be agreed upon, would be more convincing than by either alone.

It may turn out that of the two theories one is right and the other wrong, or that they are two separate effective factors with interrelated elements, or (what seems more likely to the writer) that they are two aspects of the same central problem, both necessary to a useful understanding, and capable of complete correlation.



FOREIGN TRADE AND INTERNATIONAL RELATIONS PROVIDE INNUMERABLE PROBLEMS THAT AFFECT THE ECONOMIC AND POLITICAL STABILITY OF THE WORLD. MECHANICAL ENGINEERS SHOULD GIVE THOUGHTFUL STUDY TO THE WAYS IN WHICH THEY ARE INVOLVED IN THESE GRAVE QUESTIONS

Applications of STATISTICAL METHOD *in Engineering and Manufacturing*[1]

IN DECEMBER, 1929, a round-table conference was called under the joint auspices of The American Society of Mechanical Engineers and the American Society for Testing Materials to consider the need for the use of statistical method in the interpretation and presentation of engineering data and to consider ways and means for developing the applications of statistical method in engineering and manufacturing. The meeting was under the chairmanship of Col. M. C. Rorty, then vice-president of the International Telephone and Telegraph Company, who incidentally was one of the first men in America to apply statistical method in engineering.

The majority of the seventy-six members of the conference represented large industrial organizations faced with practical problems in the solution of which they felt that statistical method might play a part. In addition, there were representatives from Government laboratories, universities, and scientific societies.

Prof. E. B. Wilson, then president of the American Statistical Society, spoke on behalf of the interest of this society, as did Messrs. C. B. LePage and W. H. Fulweiler on behalf of The American Society of Mechanical Engineers and the American Society for Testing Materials, respectively. Four papers were presented indicating some general and specific needs for the application of statistical method. Several members of the conference took an active part in the discussion of the papers. After the formal program a resolution was proposed and unanimously adopted that a committee be appointed to further the application of statistical method in engineering and manufacturing, to be composed of one member from each of the following societies: The American Society of Mechanical Engineers, American Society for Testing Materials, American Mathematical Society, and American Statistical Association. The following is a report of the committee formed in accord[2] with this resolution.

APPLICATIONS PRIOR TO 1929

It would be difficult to say when application of statistical method was first made in the engineering field. Certainly it dates back a long way if we include, as we should, the theory of errors and least squares as a part of the method. In a brief paper (1),[3] copies of which were sent out with the invitations to this round-table conference, the general nature of applications to research, development, design, production, inspection, and supply was indicated, together with a list of references bearing upon this general subject. A perusal of these references will indicate the sporadic nature of the applications made prior to this time in almost every field of engineering.

One of the first outstanding applications of statistical theory to the problems of manufacturing was that made by a man writing under the pseudonym of "Student." "Student's" work was carried on in a British brewery which is one of the largest in the world, and his publications date from 1907.

In Germany and America, active interest in such applications seems to have originated about 1922 to 1925. In fact, it was about this time that the interest of German engineers had developed sufficiently to warrant Dr. Hellmich, of the Normenausschuss der Deutschen Industrie, in calling to the attention of the American Standards Association the application of statistical method—*Grosszahlforschung*—in the German industries and asking if any like developments had taken place in America.

APPLICATIONS SINCE 1929

Shortly after the formation of the Joint Committee, a committee was formed under the auspices of the American Society for Testing Materials to treat of the applications of statistical method to special problems of this society. This committee now consists of about thirty-five members, among whom are representatives of many of the technical committees of the society. Regular meetings have been held in connection with the annual meetings of the society. In fact, a well-attended round-table conference was held this spring (1932) on the acquisition of good data, and most of the papers there presented will shortly appear in one place or another. At the present time Dr. Anson Hayes, director of research of the American Rolling Mill Company, Middletown, Ohio, is chairman of this committee.

Among other projects now under way is the preparation of a brief monograph of recommendations on the presentation of the data of this society, which is supposed to present the most efficient method for summarizing data in a way to admit of fullest information for the particular problems in hand. They also have under way the preparation of a monograph discussing the problem of rejection of observations from both a theoretical and a practical angle. The major contributions to this second monograph are to be made by Dr. E. W. Washburn, of the Bureau of Standards, editor-in-chief of the "International Critical Tables," Dr. P. R. Rider, of Washington University, and Dr. H. C. Dickinson, of the Bureau of Standards.

[1] Report as of August, 1932, of Joint Committee on the Development of Applications of Statistics in Engineering and Manufacturing sponsored by the American Society for Testing Materials and The American Society of Mechanical Engineers. For presentation at the Annual Meeting, New York, December 5 to 9, 1932, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] The committee consists of L. K. Sillcox, vice-president of the New York Air Brake Company, representing The American Society of Mechanical Engineers; W. H. Fulweiler, past president of the American Society for Testing Materials and chemical engineer for the United Gas Improvement Company of Philadelphia, representing the American Society for Testing Materials (R. E. Hess, assistant secretary of the A.S.T.M., alternate); E. V. Huntington, professor of mechanics at Harvard University, representing the American Mathematical Society; and W. A. Shewhart, engineer in charge of fundamental quality engineering, Bell Telephone Laboratories, representing the American Statistical Association.

[3] Numbers in parentheses are those of similarly numbered references given at the end of the report.

Important among the developments of applied statistics in engineering and manufacturing is that having to do with the development of methods of economic control of quality which has been recently made available in book form (2). Additional references to fields of application are given in the appendix to this book. During this same period, further contributions in this field were made by "Student," and, in addition, important contributions were made at the Shirley Institute, the research organization of the British Cotton Industry, by L. H. C. Tippett, who has within the past year published an excellent treatise on statistical method (3).

Among the active leaders in this field of application in engineering in Germany, we should mention Daeves, Becker, Plaut, Runge, Schaurte, Schimz, Schulz, and Kohlweiler. We understand that Mr. Werner Schaurte, president of Bauer and Schaurte, of Neuss, incidentally a graduate of Massachusetts Institute of Technology, whose interest in making use of statistical method in his own plant dates from about 1922, continues to be one of the most enthusiastic advocates of the usefulness of the method. Perhaps one of the most active leaders in the field of application is Dr. Karl Daeves, research director of the Vereinigte Stahlwerke Aktiengesellschaft. He is soon to publish a book, "Praktische Grosszahlforschung" (Berlin, VDI-Verlag), which will not only describe his own work in detail but will also carry a complete bibliography in this field. This book with that of Dr. Kohlweiler (4), the one by Becker, Plaut, and Runge previously referred to, and another (5) edited by Plaut, serve to cover in a comprehensive way the comparatively extensive work of the Germans. It appears that the principal engineering applications of statistical method in Germany continue to be in the steel industry, but its use is being rapidly extended to the glass, mining, electrical, and ceramic industries.

We may perhaps get the best picture of the role of statistical method in engineering by thinking of the engineer's job under three general headings:

1 Discovery of physical properties and laws
2 Presentation of experimental data
3 Use of physical properties and laws in the fabrication of goods to satisfy human wants.

It is recognized today as never before that discovery in this sense is founded on probability inference. Now, broadly speaking, statistical theory is concerned with the problem of drawing the best inference. It is, as it were, the cornerstone of the logic of discovery. The application of such methods begins with the laying out of the experimental procedure and not with the analysis of results as is so often assumed by those unfamiliar with the methodology. In complex commercial problems of research, as, for example, in the study of the properties of raw materials, important savings in the reduction of numbers of measurements to attain a given degree of precision are often made possible through the use of the method, as is evidenced, for example, in the work of Tippett already referred to and by the extensive work going on in the field of agricultural research at the Rothamsted Agricultural Station under the direction of Dr. R. A. Fisher (6).

In general, the committee believes that statistical methods constitute the best means for correcting data for errors of measurement; detecting assignable causes of variation in any phenomenon; choosing the best functional form, including estimates of parameters, for the expression of distributions and relationships; and laying out efficient research programs. The industrial applications in engineering and manufacturing previously referred to justify this belief.

Passing to the problem of presentation of data, statistical method presents the most efficient method of summarizing the *whole* of the information given by the raw data. This phase of the problem has been treated in some detail from an engineering viewpoint in Chapters V to IX of (2). Furthermore, having once decided upon the method to be used in arriving at a probability inference, statistical method indicates the most efficient statistic to be used. This is also discussed under efficiency in (2). Such studies reveal the need for modifications in the current methods of summarizing data, particularly in the statement of the properties of materials. This special field of application is being considered by members of the previously mentioned committee of the A.S.T.M. in the preparation of a monograph on recommendations for summarizing data for publication. These suggestions should be of practical value to many engineers. Our committee feels, however, that perhaps the engineering field of greatest economic significance for the application of statistical methodology is in the establishment of economic standards (7) of quality and procedures for effecting economic control of quality of manufactured product (2). Broadly speaking, statistical methodology makes it possible to establish limits within which variation in any quantity of interest to management should be left to chance. Only when variation extends beyond these limits is it economical to take action. The significance of this contribution from the viewpoint of management engineering has recently been treated in some detail by an authority in this special field (8).

It should be noted that individual corporations may hope to attain appreciable economies through the application of control methods. However, since control really should start with raw materials to attain the maximum advantages, it is desirable that engineers cooperate through organized societies in the development of economic standards, thereby rendering it possible to make more efficient use of materials and minimize the cost of inspection (9), to mention only two of the advantages set forth in the references above cited.

Quite recently the chairman of our committee, Dr. Shewhart, was invited to give three lectures on the role of statistical method in economic industrial standardization at the University of London. While abroad, he visited several of the industrial laboratories and plants in England and Germany where work of this character is under way. Arrangements were also made through the sponsor societies of our committee and the American Standards Association for him to discuss the work of our committee with the officers of some of the engineering societies abroad. While in England he had the privilege of attending a round-table conference called under the auspices of the British Standards Institution, and similar in character to the one called in 1929 by the sponsor societies of our committee. A resolution was passed organizing a committee under the chairmanship of Mr. B. H. Wilsdon, of the British Government Building Research Laboratories, to consider the development of applications of statistical method in engineering and to cooperate with our committee in this effort. While in Germany a similar round-table conference was called by the president of the Deutscher Normenausschuss which resulted in the formation of a committee under Dr. W. Hellmich, managing director of the Normenausschuss and co-director of the Verein deutscher Ingenieure, as chairman, with much the same objective as the British and American committees.

In general, these committees should be of considerable mutual help in focusing the attention of the engineering profession on important developments in applied statistical technique in the fields of engineering and manufacturing. The three round-table conferences mentioned above have already served to bring to light important contributions in certain

diverse engineering fields, and plans are under way to make this information available in published form.

Although there is general agreement that industry may profit materially in ways that we have tried to indicate in this report through the application of statistical technique as it exists today, there remains much to be done on the theoretical side. It is significant to note that these problems are being attacked not only by men in industry but also by men in the university field—in particular by Dr. Egon Pearson at the Biometric Laboratory of the University of London. Among other problems that Pearson has under way is a discussion of efficient specification of materials from the viewpoint of the latest developments in the mathematical theory of statistics.

PROGRAM OF ACTIVITY

Our committee plans to serve in every way possible as a clearing house of information: in particular, to issue from time to time reports in the journals of the sponsor societies, calling attention to the progress that has been made in this particular field, and to cooperate (*a*) with other committees representing societies and industries in America, such as that of the American Society for Testing Materials on the interpretation and presentation of data, and (*b*) with the general committees referred to in this report sponsored by the British Standards Institution and the Deutscher Normenausschuss.

W. A. SHEWHART, *Chairman* E. V. HUNTINGTON
W. H. FULWEILER L. K. SILLCOX

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(2) "Economic Control of Quality of Manufactured Product," by W. A. Shewhart: D. Van Nostrand Company, New York, 1931.

(3) "Methods in Statistics," by L. H. C. Tippett: Williams and Norgate, London, 1931.

(4) "Statistik im Dienste der Technik" ("Statistics in the Service of Technology"), by E. Kohlweiler: R. Oldenbourg, Berlin, 1931.

(5) "Fabrikationskontrolle auf Grund statischer Methoden," edited by H. C. Plaut: VDI-Verlag, Berlin, 1930.

(6) "Statistical Methods for Research Workers," by R. A. Fisher, Third Edition: Oliver and Boyd, London, 1930.

(7) "Role of Statistical Method in Economic Standardization," by W. A. Shewhart, to be published in *Econometrica*, January, 1933.

(8) "Standards for the Economic Control of Quality for Manufactured Products," by F. E. Raymond, *Industrial Standardization*, July, 1932.

(9) "Need for Statistical Control in Sampling Inspection," by H. F. Dodge, to be published shortly in *American Machinist*.

Ewing Galloway, N. Y.

PUBLIC WORKS (HOOVER DAM)

The place of public works in our economic life is of vital concern to the nation. It is a problem in which engineers particularly are interested. Their assistance is as urgently needed in the development of sound policies as it is in the preparation and construction of the works themselves

JOHN RIPLEY FREEMAN, 1855-1932

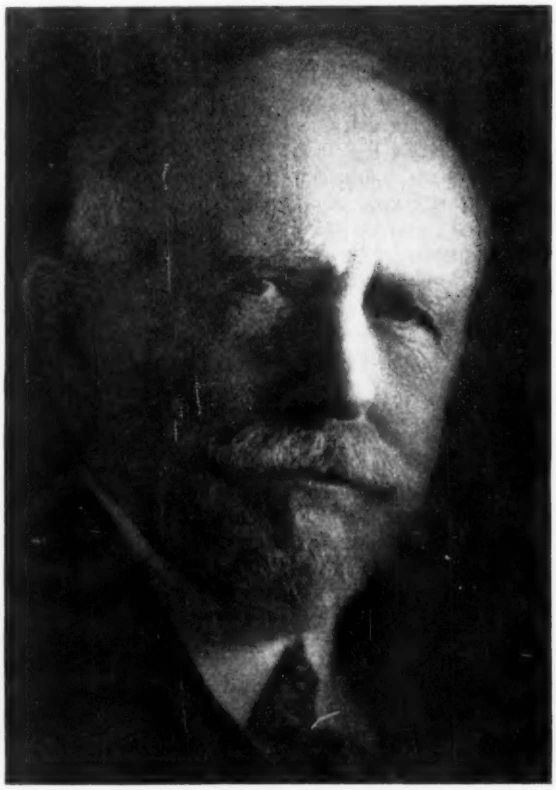
JOHN RIPLEY FREEMAN, past-president and honorary member of The American Society of Mechanical Engineers, president of the Manufacturers Mutual Fire Insurance Company, of Providence, R. I., and eminent authority on water works and hydraulics, died in his sleep on the night of October 6, following a brief illness of two days. His active life was crowded with achievements in many fields. To an unusual degree he brought the benefits of engineering to his fellow-men in many lands, giving his energy and his money unselfishly to meritorious causes and directing his talents to business and to engineering with an enthusiasm and thoroughness that made his pursuit of both these professions successful.

Known chiefly among business men for his able administration of fire-insurance companies and among engineers for his work in hydraulics, he was jokingly accused at the dinner given in his honor by the Providence Engineering Society in Providence, R. I., April 21, 1931, of being a sort of Dr. Jekyll and Mr. Hyde. Admitting that he led a "double life," Mr. Freeman said:

> Doubts have been cast on my engineering ability. I remember a very serious doubt by one of the foremost financiers of Providence. Some years ago we were sitting at lunch together in a Providence restaurant and he said, "There is a queer item in the New York paper this morning about a man—it said he came from Providence—by a name very similar to yours, who had been asked to come over to New York to be chief engineer of the Board of Water Supply, Gas, and Electricity—I thought I knew everybody of any account in Providence, but I can't seem to think of any one who answers that description." I tried to keep my face straight. He looked at me and said, "Are you the man? Why, that is strange! I never supposed you knew anything about engineering; I thought you were just president of the Manufacturers Mutual Fire Insurance Company!"
>
> On another occasion I was called on to talk about "The Lessons of the San Francisco Fire and Earthquake" at a convention of the American Society of Civil Engineers, and I held forth for more than half an hour on what I considered the great lessons of that catastrophe. About a dozen friends came up to me afterward and said, "Why, look here, Freeman, when did you ever have a chance to learn anything about insurance?"

The benefits of this "double life," Mr. Freeman argued, were that it gave him a double circle of friends. It also gave him an opportunity to bring into both of these departments of human activity a personal knowledge and experience gained in one, but applicable also to the other.

And indeed it was to these two great fields, fire insurance and hydraulic engineering, that Mr. Freeman devoted the greatest part of his life. His first job, which was in the field of hydraulics, led to his becoming engineer and inspector for the Associated Factory Mutual Fire Insurance Companies and ultimately to the presidency of the Manufacturers Mutual Fire Insurance Company, and also established his lifelong consulting practice in hydraulic engineering. Likewise his early work in factory construction in this first job fitted into the natural developments of the fire-insurance business and led to the study of earthquakes and the design of structures to withstand shocks caused by them. In any one of these fields Mr. Freeman's achievements would have been noteworthy. The combination of such varied and extensive attainments as these and others for which he was well known brought an ever increasing number of honors to him from universities, societies, and governments, in this country and abroad, and filled life so full of worth-while and interesting things to do that death found him still attacking them with vigor and unabated enthusiasm.



JOHN RIPLEY FREEMAN

HIS EARLY YEARS

John Ripley Freeman was born on a farm at West Bridgton, Me., July 27, 1855. Early education in the public schools of Portland, Me., and Lawrence, Mass., led to studies in science and engineering at the Massachusetts Institute of Technology, from which he was graduated in 1876, with the degree of bachelor of science from the department of civil engineering.

In accordance with a custom which is as sound today as it was then, Mr. Freeman spent his summer vacations in gaining profitable experience in industry, working as assistant engineer with the water-power company at Lawrence, Mass. Returning to this work after graduation, he soon became principal assistant engineer to the company and to its chief engineer, Mr. Hiram F. Mills, in whose extensive consulting practice in water power, foundations, and factory construction he participated. It was here also that he came in contact with James B. Francis, of Lowell, Mass., recognized as the foremost hydraulic engineer of his day in this country, with John C. Hoadley, the eminent mechanical engineer, and with Charles S. Storrow, one of the best educated engineers of his day, who planned the new city of Lawrence, designed and developed its water-power plant, and wrote the earliest treatise on hydraulics of water supply in the English language.

HIS WORK IN FIRE PREVENTION AND HYDRAULIC ENGINEERING

Ten years of this valuable apprenticeship led, in 1886, to Mr. Freeman's resignation to become engineer and special

inspector for the Associated Factory Mutual Fire Insurance Companies of Boston, Mass. These companies were associations of manufacturers established for the double purpose of insurance and the development of means for preventing disastrous fires. Because of Freeman's ability and technical training, he was soon asked to undertake the reorganization of the corps of inspectors maintained by the fire-insurance companies. This work he supervised for about ten years, conducting also many researches on the improvement and standardization of fire-prevention apparatus, including automatic sprinklers, fire pumps, fire hose, and the causes of fire. It was during this period that he presented to the A.S.C.E. his well-known papers, "Experiments Relating to the Hydraulics of Fire Streams," which received that society's gold medal in 1889, and "The Nozzle as an Accurate Water Meter," the gold-medal paper in 1891.

While carrying on the work of supervising the inspectors of the insurance companies, Mr. Freeman engaged also in consulting practice in Boston, Mass. This twofold interest was maintained throughout the remainder of his active life. Or perhaps it would be better to say threefold—or many fold, for the researches in which he was constantly engaged, or in which he displayed a lively personal interest, also persisted throughout his entire career. During recent years he was engaged in preparing a book on researches on the flow of water in pipes, elbows, and tees.

In 1896 Mr. Freeman was called to Providence, R. I., to become president and treasurer of what is now the Manufacturers Mutual Fire Insurance Company, the position which he held at the time of his death.

Space will not permit a complete recital of Mr. Freeman's achievements in the many fields in which he worked. While a definite chronology pertains to each, his work lay in several of them simultaneously. For convenience, therefore, a general classification of them has been attempted.

Of his business and insurance interests mention has already been made, and the success of the company he served seems adequately to express Mr. Freeman's competence and accomplishments in its non-engineering aspects. Its principal success lying in adequate fire prevention, it is only natural that a great many of Mr. Freeman's engineering achievements were also in this field. To it he brought a technical training and a valuable knowledge of hydraulics, the subject in which most of his engineering practice lay. He wrote on hydraulic and piping arrangements for the protection of cities in 1892, and on the protection of cities from fire in 1915. In 1905 he presented to the A.S.M.E. in his presidential address a comprehensive study of theater fires, their causes and means of prevention, and in 1923 this Society awarded him its gold medal "for eminent service rendered to industry in fire prevention."

A CONSULTANT ON WATER-SUPPLY PROBLEMS

In his consulting practice, as has already been indicated, Mr. Freeman made a specialty of hydraulics. It is possible to mention only briefly the principal projects that engaged his attention.

In 1895 to 1896 he was engineer-member of the Massachusetts Metropolitan Water Board.

In 1903–1909 he was chief engineer in charge of investigations for damming the Charles River between Boston and Cambridge, Mass., creating a fresh-water "basin." The project and its result is well known to all visitors to these cities.

He served, at various times, the Metropolitan Park Commission of Massachusetts on matters of river improvements and drainage.

In 1899 he was engaged by the Finance Department of the City of New York to investigate additional sources of water supply—the first step in works since built. Noteworthy researches on water waste in municipalities were conducted as part of this work.

Later, in 1904, he again served the New York Metropolitan District as a member of the Burr-Hering-Freeman Commission for further study of additional water supply, and, in 1905, became consulting engineer to the New York Board of Water Supply (a post which he filled for the remainder of his life) after having refused, because of his consulting practice and insurance business, to become its chief engineer.

Other communities came to him for advice on their waterworks problems. In 1907–1908 it was the New York State Water Supply Commission, later known as the State Water Conservation Commission, on studies for conserving water resources. He was one of the engineering commission of three reporting on the feasibility and location of the Los Angeles aqueduct, 240 miles long, from the Owens River (1906). Baltimore, Md., secured from him in 1909 designs for a new source of water supply. San Francisco employed his services from 1909 to 1912 in planning the Hetch Hetchy water-supply system substantially as it is now being constructed. He made electric-power development an important feature of this project, greatly adding to the income of the city. Nashua, N. H., Denver, Colo., Seattle, Wash., San Diego, Calif., and Mexico City also sought out his services.

HIS ACTIVITIES IN WATER-POWER DEVELOPMENT, DRAINAGE, AND FLOOD CONTROL

In the field of water-power development he was employed by the Aluminum Company of America at Massena, N. Y., at the Long Sault, Niagara, and on several southern rivers. He planned power developments on the Feather River in California for the Great Western Power Company; made investigations for the Canadian Government on water-power development in the provinces of Alberta, Manitoba, and British Columbia; designed high masonry dams for the Mexican Northern Power Company at La Boquilla de Conchos, for the Medina Irrigation Works in Texas, the Pacific Gas & Electric Company at Lake Spaulding, the Spring Valley Water Company at Calaveras, the Great Western Power Company at Big Bend, Calif., the Aluminum Co. at Badin, N. C., etc.; and assisted engineers of the U. S. Reclamation Service on construction methods for the Arrow Rock Dam near Boise, Idaho. He also designed and supervised the construction of a high masonry dam on peculiarly difficult foundations on the Missouri River at Holter, Mont.; prepared designs (not executed) for developing the Great Falls of the Potomac with a great reservoir by a single dam 200 feet high; designed extensions and to some extent supervised construction of high earth dams by hydraulic fill at Coquitlam, British Columbia, and San Pablo, Calif.; and made outline plans (not executed) for a new subterranean power development for the Ontario Power Company at Niagara and for the development of 800,000 continuous horsepower on the St. Lawrence River, near Montreal, from the Lachine Rapids, with its backwater raising Lake St. Louis nearly to its flood level.

In the field of drainage and flood control Mr. Freeman acted as consulting engineer, 1917 to 1920, to the Chinese Government on the improvement of the Grand Canal, including preliminary studies of flood prevention on the Yellow River and the Hwai River. In 1922 he prepared designs for a large railroad bridge across the Yellow River. In his plan the bridge was reduced to about one-fifth of its previous length by training and confining the river to a narrow channel. From 1924 to 1926 he

served on the Engineering Board of Review of the Sanitary District of Chicago on the controversy over the lowering of the level of the Great Lakes.

HIS PATRIOTIC SERVICES

Space will permit only the bare mention of his services to the United States during the World War on the National Advisory Committee for Aeronautics, his report on the Hog Island Shipyard, his studies, in 1905, 1908, and 1915, of various special problems of the Panama Canal; of his connection with the Providence, Rhode Island, gas company, and his studies in city planning, highways, and parks for the City of Providence.

One of Mr. Freeman's most patriotic services was his untiring efforts to secure for the United States a National Hydraulic Laboratory. The bill authorizing the laboratory was passed by the Congress under the leadership of Senators Ransdell and Hebert, and the laboratory, constructed largely in conformity to designs supervised by Mr. Freeman, was dedicated in the spring of 1932. A description of it will be found in MECHANICAL ENGINEERING, May, 1932. Many hydraulic laboratories exist abroad, and in a book, "Hydraulic Laboratory Practice," published by the A.S.M.E. in 1929 but financed and edited by Mr. Freeman, these laboratories and their work are described.

Geologists and seismologists have felt the stimulus of Mr. Freeman's enthusiasm and breadth of interest. Studies in water supply and flood control naturally presupposed a comprehension of geological formations. He was a pioneer in calling upon geologists and seismologists to aid in clearing up questions that arise in engineering works. He studied the continental depression of the New England shore line in his investigation for the Charles River Basin, and summarized new and old data and drew valuable conclusions as to continental movement in connection with his report on the regulation of the Great Lakes.

In the words of the Reverend John Joseph Lynch, S.J., representing the Seismological Society of America at the Providence dinner in 1932, "Divine Providence has decreed that there will be earthquakes, but the City of Providence through one of its honored sons and engineers has arranged that the effects of these earthquakes shall not be so disastrous." Presenting a paper before this society in 1930, Mr. Freeman was (quoting Father Lynch again) "embarrassingly insistent with the seismologists that we must make better measurements regarding the basic facts of earth motion and seismology before we can put up buildings that are going to withstand earthquake shock, and he was so insistent that one felt one had to go out and find these data." To the work of this society Mr. Freeman made financial contributions; and within the past year he brought out his 600-page book on a "Study of a Rational Basis for Earthquake Insurance."

HIS EDUCATIONAL AND PROFESSIONAL-SOCIETY INTERESTS

Not only in science, in engineering, and in business did Mr. Freeman's talents exercise themselves, but in the field of education and engineering societies as well. A graduate of Massachusetts Institute of Technology, twice president of its Alumni Association, and life member of its corporation, on which he served for more than forty years, he was offered the presidency of the institution when Dr. Pritchett resigned. Twice President Eliot offered him the chair of Civil Engineering at Harvard University. These honors he declined, feeling that his services to mankind were better engaged in the practice of his profession. He spoke and wrote on educational matters. He held honorary degrees from Brown, Tufts, University of Pennsylvania, Yale, and the Sächsische Technische Hochschule, Dresden.

In 1923 Mr. Freeman gave $25,000 each to the American Society of Civil Engineers, The American Society of Mechanical Engineers, and the Boston Society of Civil Engineers to provide for traveling scholarships in hydraulics. The first Freeman Traveling Scholarships were awarded in 1927. They enable young engineers or junior professors between the ages of 25 and 35 years to profit by a year or more of study in the best engineering laboratories of Europe.

Mr. Freeman was a loyal and active member of many engineering societies. He was an honorary member of the Providence Engineering Society, the Boston Society of Civil Engineers, the American Society of Civil Engineers, and the American Water Works Association. He was elected to honorary membership in the A.S.M.E. in 1932. (This is the first public announcement of that fact.) He was president of the Boston Society of Civil Engineers in 1893, of The American Society of Mechanical Engineers in 1905, and of the American Society of Civil Engineers in 1922.

He was a member of the National Academy of Arts and Sciences, the Visiting Committee of the Bureau of Standards, honorary member of the Badische Technische Hochschule, Karlsruhe, and Mitgleid des Wissenschaftlichen Beirats des Forschungsinstituts in Munich and Walchensee, Bavaria.

The testimonial dinner sponsored by the Providence Engineering Society in honor of John R. Freeman and several times mentioned in this review, indicated the high regard in which engineers, scientists, educationists, industrialists, and friends held this man of many accomplishments. A silver platter commemorating this event was presented to Mr. Freeman and called forth from him a gracious and graceful response. In it he testified to the benefit he had derived from his friends, and recalled that one of them, Mr. Charles S. Storrow, long since dead, had told him 50 years ago, "You can never see another such half-century as that through which I have had the good fortune to live and act." His own fifty years, he said, had seen far greater developments and inventions than had those of Mr. Storrow. He concluded his address as follows:

> Looking forward, one may well wonder where the end can be, and if the "law of diminishing returns" is not now setting in with a jump. We may earnestly question if the great jobs of that kind which have occupied us during the past two half-centuries—the great steam-railroad systems, the street railways, the hard-surface highways, the vast electrical power developments both by water and steam, the automobile transportation, machine farming, and the vast machine shops that have been called into being for all of this construction—are not now completed up to that point where we now have got to look in other directions very strongly, in order to find jobs enough to occupy all of the willing hands. To find the required number of jobs may take a long time.
>
> The great problem of the next half-century may very probably come to be the human problem, and the better distribution of the products and savings of the machine age.
>
> Possibly we now stand on the threshold of a new epoch.

In the light of the developments of the eighteen months that have passed since these utterances were made, it becomes more and more clear that a new epoch is approaching and that engineers of the ability, industry, and enthusiasm of John Ripley Freeman have before them tasks of unprecedented magnitude, variety, and richness of promise. He died in the full vigor of an active life, having accomplished more than most men, yet with keen interests in present and future work, a restless, forward-reaching spirit, a kindly, courteous, and unselfish gentleman, an engineer whom engineers have justly honored, and whose life has enhanced and brought honor to the professions he practiced.

MECHANICAL ENGINEERING

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GEORGE A. STETSON, *Editor*

Straws

IT HAS BEEN noted in the New York *Herald Tribune* that "graduates of the medical schools of many foreign universities, including all those of France, Switzerland, and Italy, will no longer be permitted to take the examination for a physician's license in New York State, because the standards of those schools fall below the level set by the State Board of Medical Examiners." Protests that greeted the Board's ruling have since resulted in its temporary modification so that students enrolled prior to January 1, 1933, will be permitted to take the licensing examinations.

All educational and license examinations in the State of New York are conducted by the Board of Regents of the University of the State of New York. The policy pursued by the Board and reflected in their action noted above is designed to raise the quality of education provided for those who must be licensed by the state to practice their profession, and, by raising the examination standards, to insure that none but a properly qualified person is licensed to practice. One of the twelve professions and vocations for the practice of which licenses from the state are necessary is engineering. A license to practice medicine in the state of New York has been required for a much longer term than one to practice engineering. It is evident that the policy of the Board of Regents, as reflected in its recent action with respect to medical schools, may be extended with equal logic to engineering schools.

An Appeal for Help

APPEALS for funds to provide relief to unemployed engineers will be received by most readers of MECHANICAL ENGINEERING in the near future, if indeed they have not already been received. While conditions vary in different parts of the country and while the manner in which such appeals are issued and the type of organization issuing them will vary, it is not likely that many engineers will fail to receive at least one request (in some cases there may be several) to contribute funds to the extent of his ability. It is urged that these appeals meet with a sympathetic and generous response.

In spite of optimistic opinions that the depths of the depression have been experienced and that an upward trend is discernible, the unemployment situation continues to be critical. Opinions, trends, statistical averages, and pious hopes do not keep the destitute from hunger and suffering, nor do they assist in any direct and practical manner the unfortunate individual who sees his life's savings vanish, his home sold out from under his helpless hands at distress prices, and his family weakened and harassed by anxiety and impoverishment. The needs of individuals in such distressing circumstances are acute and very real. In a majority of cases such individuals are the victims not of their own shortsightedness or incompetence, but of circumstances over which they have had no reasonable control. In humility and with a great measure of truth in most instances, those of us who have jobs and have suffered only the petty annoyances of hard times may say to ourselves, "There, but for the grace of God, go I," as we see one after another of our former colleagues leave his accustomed task and join the great army of unemployed.

Money is urgently needed. But better than money are jobs, jobs that will bring new hope and happiness to despairing men and the new vigor of restored morale. Both money and jobs depend upon the recovery of business, and to this end, in whatever ways lie at his hand to use, each individual owes it to himself and to humanity to work with zeal and intelligence. For mass actions, after all, are but the result of innumerable individual actions, and into one pan or the other of the scale of economic balance a man may throw his insignificant weight with the sure knowledge that by so doing he has either aided or impeded recovery.

Forest Growths Curtail Water Supply

A SIMILARLY entitled editorial appeared in the September, 1932, issue of *Power*, and was based on a paper presented at the recent annual convention of the American Society of Civil Engineers by W. G. Huyt and H. C. Proxell, respectively hydraulic engineer and assistant hydraulic engineer of the U. S. Geological Survey. The conclusion arrived at is that, contrary to the general belief of many, recent studies of forests and stream flow indicate that the maintenance of forests on watersheds greatly reduces the available water supply, and that deforestation increases the average annual accumulated excess of run-off.

In an editorial which appeared in MECHANICAL ENGINEERING for May, 1931, pp. 394–395, attention was called to the enormous rate of evaporation of subsoil water through trees. As an example, it has been stated that a full-grown tree under average summer-day conditions may evaporate as high as fifty barrels of water a day.

There is only a certain amount of water present in the soil and subsoil, coming from seepage, condensation as dew, and rainfall. If a substantial part of this water is evaporated by trees, obviously the amount that can be fed to streams and lakes must be that much reduced. Complete deforestation over extensive areas produces drying of the general climate, which is probably due to the fact that deforested land cakes and becomes impervious to water, and thus assists in rapid evaporation from its surface. Heavily forested land, on the other hand, has apparently a tendency to maintain a balance

between the evaporation from the leaves of the trees and the water held in the layer of soil containing the roots, the ground retaining a degree of moisture apparently sufficient to prevent an ample amount being fed to the streams. On the one hand, therefore, there is apparently a certain optimum amount of forestation that will protect streams from drying up completely, and prevent them from being underfed on the other. Just what this optimum forestation is we do not know, as no data of any precise character are available. As stated in the editorial in *Power*, the possibility of replanting drainage areas with a type of vegetation which will not make excessively heavy demands upon water supply for its growth as does an ordinary forest, should also have consideration. Another question which deserves investigation is whether the rate of evaporation affects tree growth favorably or unfavorably.

Aiding the R.F.C.

EFFORTS of the Administration to assist recovery through the Reconstruction Finance Corporation by making loans for self-liquidating public works can be accelerated by the intelligent cooperation of all persons interested in them. In spite of the fact that the R.F.C. has a desire to act promptly in making loans up to the limit of the amount authorized by the Congress, and in spite of the fact that a very considerable number of projects have been brought to the consideration of the Corporation, comparatively few loans have been made for public works. The reason is not far to seek, and the remedy at once suggests itself.

In the first place, there is a general lack of understanding of what the R.F.C. is legally empowered to do, in spite of the fact that its functions, powers, and limitations were specifically outlined by the Congress. In the second place, an overwhelming majority of projects brought to the attention of the Corporation either do not belong to the class of projects for which loans can be made, or their sponsors have failed to provide the data, technical and otherwise, without which it is impossible for the Corporation to act.

These difficulties being recognized, plans are being elaborated to clear them up. An extensive publicity that should reach all citizens will soon be under way covering the purposes, powers, and limitations of the R.F.C., illustrating the kinds of projects for which loans can and cannot be made, and emphasizing the need for complete plans and data.

To each of thirty-two local district offices of the Corporation are attached unpaid advisers on engineering, financial, and legal matters. If sponsors of projects would consult with these advisers before submitting their requests for loans to the Corporation in Washington, the projects that cannot be considered would be sifted out, saving much time and labor now spent on those that cannot possibly be approved, and an opportunity would be provided to check up on the completeness of the data submitted with a given project. Individual engineers can be of service in insisting that any group of citizens to which they may belong shall offer its project in complete form, and only after having assured itself that the R.F.C. is legally empowered to make loans on such a project.

It should be understood that the Engineers' Advisory Committee of the R.F.C. at Washington and the engineering advisers in the thirty-two districts are not organized to perform the duties of consulting or designing engineers. Engineers serving in the district offices will assist in making clear the procedure and advising sponsors of projects what additional data they may need to have before their requests for loans can be considered. Those at Washington make their report to the Corporation itself on the basis of the engineering practicability of the projects proposed. The function of both of these groups of engineers is to expedite the procedure of the R.F.C., and to advise on engineering features of the projects submitted.

John R. Slattery

TO BE CUT OFF in the prime of life with great deeds unfinished, and opportunities for even greater accomplishment yet to come, is the common fate of men of war. Nelson at Trafalgar, Moore at Corunna, Sir Philip Sidney, Roland at Roncesvalles, Leonidas at Thermopylae, all are legendary heroes to schoolboys because of their glorious deaths. No less glorious are the deaths that cut short careers of service to the arts of peace into which some men, in excessive devotion to duty, throw all of their energy.

To the list of engineers whose devotion to the public service and attention to the duties of the job have cut short brilliant careers has been added the name of John R. Slattery. His collapse, shortly followed by death, on the night of the opening of the city-operated subway in New York, came as a result of the unabated efforts he had put forth as responsible head of the new operation to train a great army of men in the details of their new jobs and to throw open to the use of the public a new transportation system, the design and construction of which he had largely supervised as an engineer of the Board of Transportation. The lives of thousands of citizens eager to be the first to travel in the new subway, the successful inauguration of a stupendous project that had taken millions of public dollars to put into operation, the professional reputations of his colleagues and his superiors, as well as his own reputation, were at stake. His death was the only unhappy circumstance of the successful subway opening.

The public knew little of Colonel Slattery's connection with the subway project, nor could it appreciate the responsibility that rested on his shoulders and the magnitude of the task he had accomplished. Engineers will have a keener appreciation of these facts. And much as they regret the passing of this splendid exponent of the best traditions of their profession, they are proud to acknowledge, and to have the world acknowledge, the high quality of Colonel Slattery's engineering accomplishments, and the strength and fineness of his character.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

APPLIED MECHANICS

Stress Phenomena Occurring in Pile Driving

THE article here abstracted consists of two parts, a report of a paper by D. V. Isaacs presented before the Institution of Australian Engineers and published in the Journal of the Institution, Vol. 3, No. 9, 1931, pp. 305–323, and a description of the work done by the Building Research Station, in England. According to Isaacs' theory, the monkey is assumed to hit the dolly due to its effective height of fall, and, on impact, waves are set up in the monkey and in the pile according to the theory of longitudinal waves in thin rods. (Compare A. E. H. Love, "Mathematical Theory of Elasticity," 4th ed., chap. 20.) It is then found that for values of the rate of length of monkey to length of pile occurring in practice, the waves in the monkey can be neglected.

If nothing is interposed between the monkey and the pile, the stress at the pile head will reach a high maximum instantaneously, and when reflected waves arrive from the foot of the pile the stress at the head of the pile will again change instantaneously by a finite amount, and these discontinuities of stress will travel up and down the pile. In practice, a dolly and packing are used to prevent this sudden rise of stress, and in the paper cited the cushioning effect of the packing between helmet and pile is represented for the first stage of impact by an elastic spring which thus causes a rise to a maximum in a finite time. After this maximum is reached the packing is assumed to remain of constant thickness for the remainder of the impact, unless after the arrival of the reflected wave from the foot, the stress exceeds the previous maximum, whereupon the packing is further depressed elastically until a new maximum stress is attained, and similarly for further reflected waves.

The conditions at the foot are assumed to be plastic, that is, no movement of the toe of the pile occurs until the compressive stress reaches a certain value.

The attention of the Building Research Station was first directed to the problem under discussion by complaints that, in practice, many reinforced-concrete piles were so damaged by driving to the specified depth or set that they could no longer be guaranteed to take their designed loads. It was at once felt that, in order to obtain a clearer understanding of the action of the various factors involved, it was necessary to secure a more accurate analysis of the stresses concerned than that given by the usual statical approximation.

The form of the waves set up by the impact of a heavy mass on a rod and of one rod on another rod had long been known, and the problem thus became, (1) To incorporate the effect of the different velocities of elastic waves in steel and concrete; and (2) to choose boundary conditions at the head and foot of the pile which would most closely represent the effects of the dolly, helmet, padding, and ground resistance, and would at the same time give wave forms amenable to mathematical calculation. With regard to (1) it was found that for ratios of length to diameter such as occur in piles, the effect of the differing wave speeds could be represented by longitudinal waves traveling along the pile with a mean speed dependent on the percentages of longitudinal and spiral reinforcement, and the problem could thus be reduced to that of a homogeneous pile. The equivalent homogeneous pile is, in fact, one possessing the average density of the reinforced-concrete pile and having a Young's modulus whose value is given very approximately by a formula in the original article.

The author derives equations for the value of the displacement of cross-section from the initial position of the pile for all values of time after the beginning of impact and coordinate of any cross-section of pile measured from head of pile, as well as the pressure across any section. The position of the cross-section of the pile at which the maximum stress is developed can be calculated from this formula, and it is found that this position will vary with driving conditions, and that there is the interesting possibility that a pile may have failed in its impacted portion while the portion above ground is still sound.

The final value of ζ_e (see Fig. 1, where ζ is displacement of

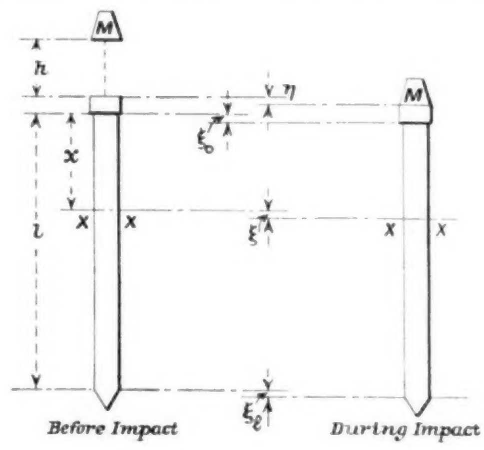

FIG. 1 NOTATION DIAGRAM

cross-section from initial position; ζ_0 displacement of head of pile; η displacement of monkey measured from position at $t = 0$, t being time after beginning of impact; l is length of pile; x the coordinate of any cross-section of pile measured from head of pile; and h, effective length of fall) gives the set per blow, and if the driving resistance is plotted against ζ_e for varying values of the constants, a pile bearing formula can be developed similar to that proposed by Isaacs.

Instead, however, the author derives a pile bearing formula of the "zero-set" type. In this case, no movement of the toe will occur and the driving resistance will be given by the maximum pressure occurring at the foot. The author considers next the strength of concrete under impact and comes to the following conclusions.

The preceding analyses indicate how the theory of elastic waves can be applied to pile-driving phenomena, and it may be said, in general, that the gain in accuracy afforded by such analyses will more than counterbalance any loss in simplicity as compared with previous theories. The gain in accuracy

will be especially great in those cases in which at any instant a large part of the total strain in the pile is concentrated over a small portion of the pile. When considering the probable damage suffered by the pile in such cases, it would appear essential to calculate the probable stresses by means of a wave analysis, which will indicate such stress concentrations, rather than by an analysis in which the stress is assumed the same everywhere along the pile. One can therefore conclude that the wave theory of the phenomena occurring in pile driving represents a distinct advance in method over previous theories, but that its advantages cannot be applied in practice to the optimum extent until experimental data have been obtained in order to substantiate the theory and enable numerical values to be assigned to the constants involved with the requisite degree of accuracy. (E. N. Fox, Building Research Station, in *Engineering*, vol. 134, no. 3477, Sept. 2, 1932, pp. 263–265, 1 fig., *tm*)

ELECTRICAL ENGINEERING

Development in the Cooling of Turbo-Alternators

In the past closed-air-circuit ventilating systems were applied on turbo-alternators—in such a way, however, that the slip rings and exciter would not be included. Recently C. A. Parsons and Co., Ltd., carried out tests which indicated that by using grilled tubes it was possible to house the whole of the cooling equipment in the space available under the machines. In its recent constructions (the three 50,000-kw turbo-alternators for the Dunston Power Station) protection has been provided for the complete unit.

As shown in an illustration accompanying the original article, two main air-circulating fans are provided on each machine, each of sufficient capacity to enable the alternator to carry a continuous load of 40,000 kw with the other fan out of service. The machines are thus capable of working at any load up to the most economical load with a single fan, and under normal conditions with both fans running the ventilation is claimed to be extremely efficient. Together with the duplicate air coolers, both fans are housed within the foundation block, and the coolers can easily be withdrawn for inspection. Apart from saving space, the arrangement permits of a much more direct and efficient discharge of the air from the fans than is possible when they are placed outside the foundations. It also reduces the volume of air in the system and thus increases the security against fire.

The fan motors alone are in the basement, and the space they occupy is insignificant. The fan bearings are in a recess and can easily be inspected without the attendant's having to enter the air chamber. Like the exciter and slip rings, the fan motors are ventilated from the main air circuit and are consequently protected against dirt and dust like every part of the alternator. The cooling air for the exciter is drawn from the main circuit by means of a fan on the armature, and after it has passed through the core and windings it travels over the commutator. It is then led by a duct in the bedplate to the slip rings and brushes of the alternator rotor, and after passing through a small viscous air filter, which is arranged in sections which can easily be removed for cleaning, it is returned to the main air circuit for recooling. The small filter is provided to insure that the air is always quite clean and free from any trace of dust from the brushes. The specification for the 20,000-kw 33,000-volt turbo-alternator under construction at Heaton for the Electricity Commissioners of South Africa calls for the ventilation of the exciter and slip rings in accordance with the Parsons method. (*The Engineer*, vol. 154, no. 3996, Aug. 12, 1932, p. 165, 1 fig., *d*)

ENGINEERING MATERIALS

Aluminum-Brass Condenser Tubes

The article here considered deals with condenser tubes made of Alumbro metal, which is the trade name of an aluminum brass made in England by the I.C.I. Metals, Ltd. The features of manufacture disclosed show that a method of casting of the ingot is employed enabling the metal to be poured into the mold without turbulence or splashing, thus insuring that sound castings are obtained. Hollow castings on sand cores are not used, and instead the billets are cast solid. The billet is thereupon heated in a furnace to the proper temperature and then pressed into a hollow shell in a new type of high-pressure extrusion press. The extruded shells are cold drawn into tubes by a series of drafts, and between each set of drafts the tubes are annealed. The mechanical properties of finished condenser tubes are similar to those of 70–30 and 70–29–1 brass tubes, but it is claimed that the metal does not scale when subjected to high temperatures. The original article describes in brief the methods of corrosion tests and tests for corrosion-erosion. Tubes of this metal have been used on commercial vessels and a battleship for the last three or four years, and are said to have given satisfaction. The specific gravity of Alumbro is about $2^1/_2$ per cent less than that of ordinary brass and Admiralty brass, but the cost per pound is slightly higher. (*Mechanical World*, vol. 92, no. 2378, July 29, 1932, pp. 106–107, 5 figs., *d*)

Wood Conservation

In the present paper the methods so far used for the preservation of wood are reviewed, and an examination is made of the prospects of improvement of certain methods of treatment, particularly the use of arsenic as a preservative.

Recent researches by Falck, Curtin, and others, including toximetric measurements as well as practical tests, have given results similar to those of the author's experiments, namely, that arsenic, especially in the form of arsenious oxide, protects wood against wood-rotting fungi, insects, and ship worms more effectively and more economically than any other substance.

For preserving telegraph poles, etc., a bandage method has been worked out which allows of a very simple treatment of the piles on the spot where they are to be put up. The alternate effects of damp and dry conditions, the properties of the arsenious oxide, and the way the bandages are put on, lead to a kind of natural impregnation, the result of which is an exceedingly long life for the poles, with at the same time very little risk of poisoning to people or domestic animals.

The use of the bandage method just mentioned involves the great advantage that the wood can be treated on the spot and need not be carried to and from a special impregnating establishment.

The actual procedure is very simple, and the preliminary treatment of the wood, such as complete peeling, and, what is most important, seasoning—which is essential when using, say, creosote—is also largely eliminated. Here the poles can be treated straight away, seasoned or unseasoned, and need only be peeled completely at the place where the bandages are to be put on.

Considerably less arsenic is used than, for instance, creosote in vacuum-pressure impregnation, and the arsenic is very cheap. Instead of 50 lb of creosote per pole, or even 150 lb for complete impregnation, only 10 lb of arsenic are required, and even that is a very ample estimate.

By the unique toxic power of arsenic and the action of the

bandage method a better preservative effect is obtained than by the best previously known method, i.e., impregnation with creosote.

In the first place, the poison permeates the surface layers and cracks of the wood, after which the alternate effects of damp and dry conditions cause the impregnation to penetrate gradually further and further into the wood. Since arsenic has a low rate of solubility, and the quantity of poison is relatively large and protected from being washed away, the arsenic bandage lasts a very long time, in marked contrast to the usual bandages prepared with more soluble and less effective salts.

By the addition of soda, a primary dissolution of the soluble sodium arsenite formed will result in, so to speak, a preliminary immunization of the cracks and superficial layers.

The arsenic has absolutely no injurious effect on wood or iron.

On the other hand, arsenic is by no means innocuous to men and animals. [Bertil Stalhane in *Proceedings of the Royal Swedish Institute for Engineering Research*, no. 118, 1932, pp. 1–47 (in Swedish), bibliography and references, pp. 48–49, summary in English, pp. 50–52, 13 figs., *pd*]

HEATING AND VENTILATION

Development of a Direct-Contact Water Heater

THE desirability of gas as a fuel for heating residences has long been recognized, but on account of economic factors its use has been restricted to regions where very cheap gas is available. One of the factors which has contributed to restricting employment of domestic gas heating has been the low efficiency of practical heating devices available for residence heating with gas fuel.

The reason for this low efficiency lies in the heat losses in domestic furnaces. The object of this investigation was to develop an apparatus that would utilize gas as a fuel in a more economical manner than is now being done, and since the chimney loss of heat is of the greatest import, it was the one studied. It was proposed to improve the heater in the following manner: First, to design a burner that would admit of the positive control of both primary and secondary air, thus reducing excess air to a minimum; second, to provide a means of mixing the burned gases directly with the water to be heated. By so doing the loss due to incomplete combustion and excess air would be prevented, the heat from the water of combustion would be conserved, and most of the sensible heat of the gases would be absorbed by the water.

A number of trial plants were constructed and are described in detail in the original article. In an early part of the work it was established that gas was burned at various rates over the entire range of the burner capacity, always with the invariable result that the temperature of the exhaust gases was practically the same as that of the water leaving the boiler. This firmly established the possibility of a successful liquid heater of the direct-contact type. Attention was next directed to a satisfactory design of the burner.

An important part of the heater is the spray nozzle. The one first used had an angle of spray of 60 deg, and would allow 230 gal of water to pass per hour at a pressure of 18 lb gage. The nozzle was set high enough above the tubes in the mixing chamber to allow the spray cone to come into contact with those nearest the outside.

The spray had two functions: first, to produce the draft necessary to draw in the gases; and second, to distribute the water over the tubes. The effectiveness of heat absorption depended upon how completely the water film covered the tube surface and on the time of contact between the gases and wetted surface as they passed through and between the tubes.

The most successful arrangement thus far designed is shown in Fig. 11 of the original article, while the details of the burner are shown in Fig. 12.

The details of the design of the various elements entering into a heater are extensively discussed in the original article. The matter of the spray nozzle is of particular interest. This device performs two essential functions: namely, it distributes the water over the surfaces in the mixing chamber, and it produces draft for entraining the gases as they arrive. There are two variables that must be considered in connection with the nozzle, both of which affect the economy of operation: the quantity of water used, and the pressure required. If the nozzle is so made that much water at a higher pressure is needed for producing the draft, it increases the power required for pumping and so the cost. If, on the other hand, a small amount of water is sufficient at a moderate pressure, less pump work is necessary.

The requirements are dictated by the performance of the mixing chamber. A required and definite amount of heat must be delivered to the radiators per hour, and this may be done by either circulating a large quantity of water with a small temperature drop or a small amount with a greater temperature difference. The spray nozzle must therefore be proportioned to the requirements of the mixing chamber for heating as well as to the production of draft.

Early experiments showed that it was quite possible to have so much draft as to pull the flame away from the burner, and it was further observed that the quantity of combustion was poorer with too strong a draft. This was especially noted when the gravity burner was used and secondary air was admitted through ports in the walls of the combustion chamber. With the Premix fan the quality of combustion was not affected by the draft so far as could be discerned.

The pump is the heart of the system, and it must possess certain definite characteristics in order to give satisfaction. These are discussed in some detail in the original article and may be briefly stated as follows: (1) The ability to handle the required amount of water at a comparatively low head; (2) the ability to start against full pressure load; (3) quietness of operation; (4) little fluctuation and constant pressure at the nozzle. The centrifugal or turbine pump is said to be the most suitable kind to use with this type of heater since it does not fluctuate in speed and maintains a constant pressure at the nozzle. This is highly desirable for the proper functioning of the nozzle.

The experiments carried out with the apparatus covered in particular the subjects of heat absorption in the apparatus; temperature rise of water during cycle; effect of exhaust gases on the water; and thermal efficiency. In the course of the investigation it was found that:

1 The products of combustion resulting from the burning of gas may be mixed directly with water and have their temperature reduced to practically that of the water being heated.

2 The latent heat of water formed during the burning of gas may be conserved by mixing the gases of combustion with the water being heated.

3 When the hot gases are mixed directly with the water being heated, the thermal efficiency of the heater is based upon the gross heating value of the gas. There is therefore an increase of economy of operation amounting to about 10 per cent over what would result were the net heating value taken as a basis. (L. A. Scipio in *Engineering Bulletin, Purdue University*—Research Series, no. 38, vol. 15, no. 5, Sept., 1931, 48 pp., 13 fig., *deA*)

LUBRICATION

Crankcase Draining

THERE are four types of oil degradation: namely, extreme dilution, saturation of oil with suspended carbonaceous material and grit, accumulation of organic acidity with its attendant rapid development of sludge, and emulsification of the lubricant. The most serious result of the second type of oil degradation, namely, saturation with foreign solid material, is wear. The wear does not completely stop when the oil is changed unless the change is made before severe wear begins. The foreign material imbeds into the comparatively soft babbitt and sets up a lapping action on the steel shaft. The same action takes place in the cylinders when aluminum pistons are used. Very rarely is there sufficient condensation in the crankcase of the engine to cause any trouble. However, when it forms in the crankcase, it leads to the formation of a sludge which plugs oil screens or causes oil rings to stick. The original article contains charts showing progressive deterioration of motor oil in actual bus operation. The graphs show the increase in the acidity and sludge. The data in the article would indicate that the matter of selection of time to drain the crankcase oil is a serious one. It is stated that the laboratories of the Standard Oil Development Company have run tests with various operators and have yet to find an oil fit for further use that has given as much as 5000 miles of service, with 2000 miles as a good average distance when oil change becomes necessary. Comparatively frequent changes are therefore recommended, and it is stated that the additional cost per mile is very low. (*National Petroleum News*, vol. 24, no. 25, June 22, 1932, pp. 36–39, 2 figs., *gp*. Compare editorial on p. 9, where incidentally it is stated that two of the largest-selling low-priced cars are not factory equipped with oil filters. The Ford has never been so equipped at the factory, and the Chevrolet dropped the filter recently to keep cost of the car low.)

MARINE ENGINEERING

Exhaust Boilers on Passenger Liners

THIS article describes the installations on the motorships *Carnarvon Castle*, *Asturias*, and *Alcantara*. On the *Carnarvon Castle* a Clarkson thimble-tube boiler was installed. This boiler is 8 ft. in diameter, with an overall height of 18 ft 3 in., and is intended to raise approximately 5000 lb of steam per hr at a pressure of 100 lb per sq in. The boiler is to take the exhaust from only one of the main engines, which it was found would supply all the steam that is necessary when the vessel is under way. The boiler is installed in such a manner that, after passing through it, the exhaust gases escape directly to the funnel. There is a deflector valve which enables the gases to be bypassed direct from the existing silencer if required. But if they pass through the boiler there is no further silencing. A very considerable saving in cost of operation with the exhaust-gas boiler is claimed.

In the *Asturias* and *Alcantara* the engines are designed to develop about 7500 bhp. The installation is similar to the one previously described in that that same type of boiler is used in each case, and the exhaust gases from one engine only will be passed through the boiler.

A novel arrangement has been devised for controlling the quantity of gases actually passing through the boiler, and therefore the amount of steam raised. There is a center core in the form of a plain cylinder 2 ft 8 in. in diameter. This can be raised and lowered, through the intermediary of a winch, level with the bottom of the boiler, and a chain passing over pulleys. When the core is raised to its maximum height, the exhaust gases are merely directed from the inlet pipe straight through the center of the core to the silencer, and do not pass over the thimble tubes of the boiler. In that case no steam is raised. On the other hand, if the central core is lowered to its bottom position, the whole of the gases pass over the thimble tubes, and the maximum quantity of steam is raised. Any amount between minimum and maximum can be generated according to the position of the central core.

At the top of the boiler the chain is attached to a rod, which passes through a packed gland to prevent any exhaust gas leaking into the engine room.

There are thirty rows of thimble tubes 15 in. $\times$ 4 in. $\times$ $2^3/_4$ in., having a vertical pitch of $4^3/_8$ in. Twenty-eight rows have 28 tubes per row, and two rows have 24, in addition to four steadies. The inner shell plating of the boiler is $1^3/_{16}$ in. thick. The bore of the exhaust pipe is 2 ft 4 in., and the inlet to the boiler is 2 ft 10 in. in diameter. The inlet piece is coned. There are steady stays between the boiler and the core to guide the latter, and a clearance of $^3/_{16}$ in. is allowed between the steady stays and the center core. The total lift of the core is 1 ft 5 in.

The fact that exhaust-gas-boiler installations on new motor passenger liners have tended to increase, as, for example, the plant on the *Georgic*, capable of raising nearly 14,000 lb of steam per hr, and those on the *Neptunia* and *Eridania*, shows that shipowners are desirous of making fuller use of the heat in the exhaust gases of internal-combustion machinery than in the past. In some existing liners the amount of oil used for auxiliary purposes is large, and, for instance, on the *Gripsholm* it varies between 4 and 8 tons daily. It is clear that in times when maximum economy is necessary, such a potential source of saving cannot be ignored.

It may be that exhaust-gas installations will develop in another way, as, for instance, was exemplified in the *Otaio*, where the steam is supplied to a turbo-generator, which supplies part of the electric power needed for the ship. A development along these lines for larger passenger liners is not improbable, for it may enable a smaller capital expenditure by a reduction in the amount of Diesel-engine auxiliary power needed. (*The British Motorship*, vol. 13, no. 150, Aug., 1932, pp. 186–187, 2 figs., *d*)

METALLURGY

Commercial Sponge Iron

THIS article describes the Wiberg process, operated in Sweden. In this process the ore is reduced in a shaft furnace by means of an ascending current of gas from a special carburetor. In order to keep the gas rich in carbon monoxide in spite of the oxygen it picks up from the ore, a part of it is withdrawn half-way up the shaft, and the carbon dioxide it contains is changed back to monoxide in the carburetor. This reaction absorbs a considerable amount of heat, supplied by electricity through electrodes. The portion of the gas that mounts beyond the point of withdrawal contains carbon monoxide which is burned in the upper part of the furnace to heat the descending ore by blowing in air, so that the gas at the top is almost completely burned to carbon dioxide and carries off very little sensible heat. A detailed description of the reactions going on in the furnace is given in the original article. The carburetor constitutes the main feature of the Wiberg process and furnace. It is a steel cylinder suitably lined and enclosed, fitted with two electrodes, and partly filled with ordinary coke.

The temperature of the coke is kept up to the point of incandescence by energy supplied through the electrodes. As the fuel does not come in contact with the ore, fuel of a low grade can be used.

The trials of the process in Sweden started in 1920. Three plants have been put in thus far, the latest one at Domnarvet, in 1931. This plant has been producing daily about two tons of sponge iron regularly for the past twelve months, using a wide variety of ores. The results from its operation show that in a commercial plant with carburetor alone the electric energy required per 1000 kg (2200 lb) of sponge iron is 1067 kwhr, and the coke, 2 or 3 kg. (446 lb). The process might be suitable where a supply of ore in conjunction with cheap hydroelectric power is available. (*Iron and Steel of Canada*, vol. 51, no. 9, Sept., 1932, pp. 105–106, 3 figs., *d*)

MOTOR-CAR ENGINEERING

One-Man "Sentinel" Steam Wagon

IN THE British Road Act it is ruled that in cases in which there is only one man in charge of a steam wagon, he must stop the vehicle when it is necessary for him to attend to the fire. To meet this situation and avoid the necessity of stopping, the Sentinel Company devised a truck with an automatic fuel and water control, which in addition, achieved a clean driver's cab. The coal is carried in a steel hopper with a filling chute at the back of the cab. The coal after passing through the crusher is fed by a screw through an enclosed casing, and passes through openings in the sides to the boiler and firebox and on to the rotating grate. It is claimed that an even distribution of fuel over the surface of the grate is obtained and the damping down of the fire by intermittent charges of fresh unburned fuel prevented. The boiler-feed pump is engine driven, and normally it delivers water at a rate proportional to the engine speed. But the thermo feed system was installed, making the supply of feedwater proportional to the supply of fuel. A lever in the driver's cab permits varying the rate of fuel feed to suit the quality of the coal being used and the practical running condition. (*The Engineer*, vol. 154, no. 3997, Aug. 19, 1932, pp. 189, 1 fig., *d*)

PETROLEUM TECHNOLOGY

Water Vapor in Natural Gas

NATURAL gas may contain varying amounts of water, which in the past has been removed by drip pockets. The presence of water vapor in natural gas as a vapor is not undesirable except possibly as a diluent, but when it condenses it causes trouble and losses. Natural gas when in the presence of water absorbs water vapor, the quantity taken up depending on the volume and temperature. There are vapors in natural gas other than water vapor. These are the natural gasoline and "bottled gas" constituents, and whether or not the removal of these gasoline vapors causes indirectly the precipitation of water in pipe lines has been the subject of some discussion and speculation. The author believes that the presence of gasoline absorption plants is likely to affect the amount of water vapor in the gas, and that there exist in the gasoline absorption plant two opposing conditions: namely, the removal of gasoline tends to precipitate water, and the gas being washed with water tends to absorb water vapor until it is saturated. Three sets of curves given in the original article show the relations of pressure at which gas leaves the absorbers to the water-carrying capacity of natural gas. From these the conclusion is derived that at low temperatures and high pressures a change either in pressure or temperature is accompanied by a relatively small change in the water content. On the other hand, at low pressures and temperatures a small change either in pressure or temperature brings about a change in the water content that is quite appreciable. Another curve shows for a given water-vapor content the value to which the pressure of a gas must drop in order to avoid the condensation of water vapor accompanying a reduction in the temperature. The author thinks that the lower the temperature and the higher the pressure of the gas as it leaves the well, the compressing station, or the gasoline plant, the less is its water-carrying capacity and, it follows, the less will be the tendency for condensation to occur.

Many operators have found, for the above reasons, that by heavily dripping the sections of their pipe-line systems nearest the field, and for the first few miles on the discharge of each compressor station, a practical solution of this problem is sometimes obtained. However, it is not an uncommon occurrence to find that water has accumulated in the least-expected places.

This is illustrated by the experience in connection with the Chicago natural-gas line. From this discussion dealing with the subject-matter from a pipe-line-transportation standpoint the author proceeds to the matter of distribution, i.e., the effect of the presence or absence of water vapor in natural gas upon the pipes, pipe joints, domestic meters, and other equipment of the distribution system of an American city served with natural gas.

The general conclusion to which he comes is that with proper jointing material a distribution system of steel pipe, cast-iron pipe, or a combination of the two is fairly tight and moist.

In the event natural gas is introduced into such a distribution system, supplanting the manufactured gas, as has been done recently in many cities in the South, Middle West, and West, a condition is set up which, if allowed to continue, may involve a great expense, first, in gas lost, and second, in remedial measures that must be taken to correct the leakage set up.

The condition referred to is the drying-out effect caused by the but-partially-saturated natural gas. Although at the point of delivery, near the city border, the gas may be saturated, in the low-pressure distribution mains where it is customary to carry but 6 to 10 in. of water pressure the degree of humidity will be considerably decreased, due to the change in pressure.

The methods adopted to prevent joint trouble at a distribution plant at Denver, Colo., which for nearly half a century carried saturated manufactured gas and then passed to natural gas, are described in the original paper.

Previous experience in Fort Collins, Colo., Cheyenne, Wyo., and Shreveport, La., coupled with the results of these Denver laboratory tests, indicated the importance of sending only saturated gas through Denver's distribution system. Experience at Cheyenne also had shown that once a system is allowed to dry out and is leaking badly, the original condition of the joints cannot be restored. A program was therefore determined upon to treat Denver's natural-gas supply in such a manner that the condition of the joints would remain unchanged.

This meant that the physical characteristics of the new gas should be made to resemble as nearly as possible those of the old gas. The physical condition of the joint materials was in equilibrium with the manufactured gas, and it was most essential that this state of equilibrium remain undisturbed.

It was therefore decided to water-saturate the natural gas at low pressure and to inject a light hydrocarbon oil into the gas

stream, the latter to simulate as nearly as possible the light tar oils in the manufactured gas and in pipe joints.

To duplicate exactly the physical characteristics of these tar oils was known to be practically impossible. On the other hand, Dalton's law indicated that if they were not exactly duplicated, they would in time leave the joint. A light gas oil was chosen, not with a great deal of confidence that it would prevent the evaporation of the light hydrocarbons in the joints, but it was hoped that it would itself be absorbed and in a way replace the naturally deposited condensates. It was known, however, that the injection of oil would tend to cement the scale and rust to the pipe walls.

Inasmuch as Denver's natural-gas supply contains no oxygen, there was no possibility of setting up a corrosive condition by the introduction of water.

The gas was water-saturated at the temperature of the main and the method of saturation is described, as well as the calculation of the steam requirements for saturating 1000 cu ft of gas. (C. H. M. Burnham in a paper before the American Gas Association, abstracted from preprint, 11 pp., 6 figs., *dp*)

POWER-PLANT ENGINEERING

The Doby Stoker for Small and Medium-Sized Boilers

THIS is a description of a relatively inexpensive stoker first devised during the war by the Dutch engineer Ridder Van der Does de Bye as a means of burning Indian coal smokelessly in marine boilers, and recently applied to a number of stationary

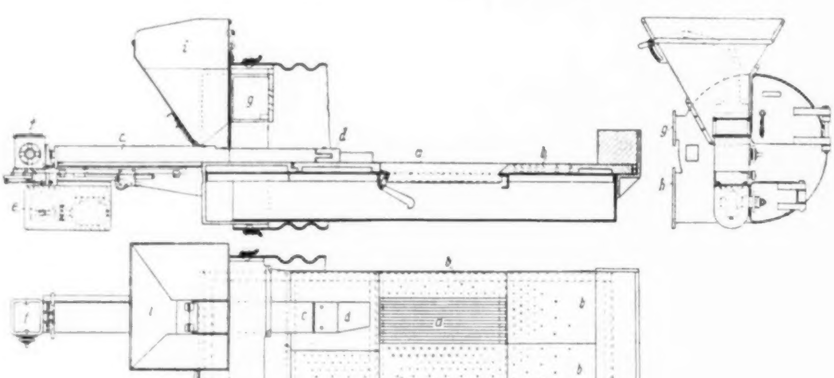

FIG. 2 THE DOBY STOKER

installations in Germany. The general arrangement of the stoker is shown in Fig. 2. It is of the coking type with ram feed and stationary horizontal grate, and instead of the coal being propelled uniformly from the front to the back of the grate it is pushed on to a central primary grate *a* and is displaced thence by subsequent charges of fuel on to the surrounding secondary grate *b*. An electric motor and crankshaft in the box *e* operate the gearing *f*, which drives to and from the ram *c* and its renewable head *d*. Coal descends from the hopper *i* on to the feed plate in front of the retracted ram, and is then pushed on to the main combustion grate *a*, which occupies about 10 per cent of the total grate area.

Primary air is supplied through the connection *h*, and secondary air through *g*. The primary grate is composed of bars with a large air-space area, while the secondary grate consists of plates with air holes diminishing in size and number from the center toward the edges as shown. The raw coal is dried and partially degasified during its approach to the grate *a*, where its combustion is mainly effected under regulable conditions as regards primary and secondary air supply. A long stroke of the ram then breaks up the coke, shifts it to the side and end grates *b*, and simultaneously cleans the primary grate *a*. At the same time, of course, the residual fuel displaced from *a* is replaced by a charge of preheated and ignited fuel which has been accumulated on the charging plate by the several preceding shorter strokes of the ram. Ash falling through the grate is removed through the ashpit door, and clinker collecting on the secondary grate is withdrawn periodically by hand through the firedoor. It is an important advantage of this stoker that the removal of slag does not affect combustion on the primary grate. Coal of high ash content can be burnt efficiently and without any difficulties in operation.

The loss of fly-coke is naturally less with caking than with non-caking coals, and is greater with slack than with nut coal. Generally, however, the loss from this cause remains below 4 per cent for all coals of 20 to 40 per cent volatile content at grate loadings up to 25 lb per sq ft per hr, and is 1 per cent or less in the case of nut coal of 28 to 38 per cent volatile content. Smokeless combustion is maintained even with gassy coals and CO_2 values as high as 14 to 16 per cent. The automatic cleaning and effective air cooling of the primary grate reduce grate-bar troubles to a minimum, and experience shows that overall maintenance costs of the stoker are exceptionally low. It is claimed that the first cost is 20 to 25 per cent lower than that of underfeed-type stokers, and that the only labor required is a few minutes every two hours for the removal of clinker.

A table in the original article gives data from tests with three different fuels on an old Lancashire-type boiler fitted with a Doby stoker. The efficiency with slack forge coal was only 75.30 per cent. With two other coals it was better than 82 per cent. It is stated that in tests in Holland, boiler efficiencies of 85 to 89 per cent were found. The low efficiency of the slack forge coal is attributed to the character of the fuel. (*The Steam Engineer*, vol. 1, no. 12, Sept., 1932, pp. 530–531, 1 fig., *de*)

First Cost of Steam-Boiler Plants

THIS article is based on a German book, by E. Praetorius, on "Cheap Boilers and Cheap Steam," which deals, of course, primarily with German conditions.

The main factors affecting the first cost of a boiler plant are the type of boiler, method of firing, size of the boiler, its specific output and overload capacity, and its steam pressure and efficiency. As regards the type of boiler, the fire-tube boiler is still the cheapest for small units, particularly with mechanical or semi-mechanical firing. Fire-tube boilers with powdered-coal firing are somewhat more expensive, while those with stationary grates are cheaper. The difference in cost, however, is not great, because these differences in the absolute cost of installation are largely smoothed out by the differences in specific outputs, which are lowest with stationary grates and highest with powdered-coal firing.

Of the water-tube boilers the inclined type are from 5 to 10 per cent cheaper than sectional boilers of the same output. Of the more recent types, the radiant boiler, because of its great specific output per unit of heating surface and low weight of iron and brick work, is considerably cheaper than any other

type of boiler, and a careful computation of the costs of a boiler plant for an output of 70 metric tons of steam per hour at 40 atm gage pressure gave, for example, the following relative figures: Radiant boiler, 100; inclined-tube boiler, 118; and sectional-chamber boiler, 133.

The type of firing selected has quite a material influence on the cost of installation. In the case of powdered-coal firing individual grinding units are cheaper than a central grinding plant, but even where individual grinding units are used the cost of the boiler plant with pulverized firing for small and medium-size installations is from 10 to 20 per cent higher than in the case of boilers with grate firing. It is only in large units (1000 sq m = 10,764 sq ft of heating area and up) that the difference in cost begins to decrease. As regards grate-fired boilers, those with zone traveling grates are on the whole cheaper than those with the conventional traveling grate, due to the high specific output of the former, and are from 5 to 10 per cent cheaper than boilers with under grates.

A boiler with a mechanical grate for burning brown coal costs approximately the same as a boiler with a traveling grate. When pure-radiant-type boilers are used the conditions under certain circumstances may be entirely different. Radiant-type boilers are of a construction that is best suited for powdered-coal firing, and therefore are of a more complicated and expensive design than other boilers. It is said that some German types of radiant boilers have been found to cost less in small units with powdered-coal firing and individual grinding mills than with grate firing.

As the size of the boiler increases, the specific items of first cost decrease, this decrease being greater with powdered-coal-fired boilers than with grate-fired.

The specific first cost can be materially reduced by raising the specific grate or fire-box output and by a corresponding increase in the specific output of the heating surface. The author supports this by referring to a calculation published by Münzinger in *Zeitschrift des Vereines deutscher Ingenieure*, Vol. 74 (1930), p. 499. This calculation is not repeated here.

The matter of overload capacity affects the specific first costs of peak-load boilers in electric central stations. Boilers with high overload capacity are affected by an increase of cost through the necessity for more generously proportioned fire chambers, grates, blowers, preheaters, etc., but considering the total installation cost and the additional output for taking care of peak loads, these factors are not material.

Maier says, for example, that the first cost of a boiler of 90 metric tons per hour normal capacity increases in cost from 11,400 to 12,200 marks per ton-hr, i.e., about 7 per cent, when the design is modified to give the boiler an overload capacity of from 25 to 60 per cent. The costs on the basis of maximum overload for a normal-type boiler are 9130 marks per ton-hr, and for a boiler with high overload capacity, only 7600 marks. It would appear, therefore, that the costs for the overload alone, which are of predominant importance as affecting the economy of peak-load operation, are in the case of a high-overload-capacity boiler only 2880 marks per ton-hr. If one takes into consideration in addition to boiler costs the further costs incurred by the use of high-overload-capacity turbines and generators, it may be found from Maier's calculations that the total first cost for peak-load plant is from 40 to 50 marks per kwhr, whereas a Ruths storage apparatus with stand-by turbines costs at least from 120 to 150 marks per kwhr. High-overload-capacity boilers are therefore well adopted for taking care of peak-load operation, because of their low initial cost.

The specific first costs increase as a rule with increase of boiler pressure, partly because of the use of the thicker walls necessitated by the higher pressures, and also because of the employment of expensive materials of construction, usually selected to provide the necessary factors of safety of operation. The manufacture of boilers of higher pressures is also usually more expensive, particularly in the case of the boiler drums. On the whole it may be stated that up to 30 atm gage the boiler pressure has no material influence on the first cost, but when it exceeds 30 atm gage, the specific first costs figured on one metric ton of steam per hour rise by jumps from 30 to 35 atm gage. However, this is only in the case of very high pressures and the employment of special methods of construction for the highest-pressure steam (for example, the Loeffler boiler). Do the first costs increase very materially over the cost of low- and medium-pressure boilers, as indicated by the authority cited in the original article? It should be noted that in the case of straight power plants, costs cannot be reliably compared on the basis of tonnage of steam per hour, because a ton of high-pressure steam has a much higher energy value than a ton of medium- or low-pressure steam. For a similar output of electric energy, less steam must be used with the former, and hence the size of the boiler would be smaller. If one takes into account this decrease of size of boiler through increase of pressure, it will often be found that high- or super-high-pressure boilers in terms of cost per kilowatt of output are barely more expensive than boilers for medium pressures. Moreover, the economics of high-pressure operation are based not on the cost of the boiler alone, but on the cost of the entire power plant, i.e., the boiler with its accessories, piping, turbines, generators, condensers, and precoolers. According to Münzinger (in a work published in 1929 under the title, "The Most Economic Steam Pressure for Electric Power Plants With Respect to the Loeffler Boiler"), the first cost of a power plant increases in proportion to the steam pressure to the extent of about 2 to 3 per cent for every 20 atm gage of increase of pressure. As a rule, however, these figures should not be employed without further consideration, as they are intended merely to indicate a general basis for estimating the influence of rise of steam pressure on the first cost of the boiler.

There are many opportunities to cut down the first costs by sacrificing boiler efficiency. Thus one may save on the cost of heat insulation by permitting higher radiation losses. In this case, however, the savings can only be small, while the disadvantages of high radiation losses are great both from the point of view of operation and of heat economies. Another way to save money on first cost is by resorting to very high specific outputs at the cost of an unavoidable high loss in cinders. Whether this is economical will, in the first place, depend on whether even with an escape of a large amount of coal dust, it is possible to operate without dust catchers, and whether the saving in initial cost through increase in output is large enough to pay for the installation of a dust-elimination plant. The third and most important method of cutting down first costs is the omission of any extensive utilization of the stack gases, i.e., omission of preheating surfaces. Krug [*Die Wärme*, Vol. 52 (1929), No. 48, p. 909] estimates that by reducing the efficiency from 90 to 85 per cent, i.e., by increasing the stack-gas losses to the extent of 5 per cent, the first cost is reduced by 22 per cent, but that a further reduction of efficiency to 80 per cent gives a saving in first cost of only 8 per cent. Any further reduction in efficiency does not produce any saving in first cost, as a major part of the costs of a boiler are entirely independent of its efficiency.

Taking all the factors into consideration, the author states that the average specific first costs of installation under present German conditions may be estimated in German marks per ton per hour, as follows:

	Marks
Fire-tube boilers	5,000 to 7,000
Smaller water-tube boilers with heating surface up to about 500 sq m (= 5382 sq ft)	15,000 to 20,000
Larger water-tube boilers with up to about 1000 sq m (= 10,764 sq ft) heating surface	12,000 to 15,000
Large boilers with heating surface in excess of 1000 sq m	7,000 to 12,000

These prices cover firing (in the case of pulverized firing, the grinding unit), boiler, superheater, preheater, and accessories, and constitute from 50 to 60 per cent of the total cost of the boiler house. The other costs comprise the structure, smokestack, coal storage, coal-handling equipment, feed pumps, water-treatment units, ash removal, piping, and dust-elimination plants. The total costs of the boiler house as a whole are therefore from 25,000 to 35,000 marks per metric ton of steam per hour for medium and small installations, and from 14,000 to 22,000 marks in the case of large installations. The stand-by boiler capacity adds from 15 to 20 per cent to this cost. The costs cited in the article for German conditions are said to have come down materially because of the intense competition now prevailing, as well as for other reasons. (From a review of E. Praetorius' book, "Billige Kessel und Billiger Dampf," in *Die Warme*, vol. 55, no. 27, July 2, 1932, pp. 472–473, *pc*)

Tests of a 3000-Rpm Large Steam Turbine

THE steam turbine referred to here is of the Siemens-Röder construction. Since the Siemens-Schuckert Co. took over the Mülheim plant it has been devoting increased attention to the development and construction of large steam turbines to run at 3000 rpm, and has actually gone as far as units of 60,000 kw, incidentally finding that the efficiency of these units materially exceeded expectations. In these large turbines the two-housing construction (a single-flow high-pressure housing and a double-flow low-pressure housing) became necessary because of the large heat drop (at the entrance live steam of 20 atm or higher pressure is used, with high vacuum through fresh-water condensation) and because of the large volumes of steam that have to be handled (100 or more metric tons per hr), and hence large volumes of exhaust steam. For outputs of 50,000 kw and a high vacuum, two double-flow low-pressure housings connected in parallel have been used, so that the whole turbine comprises three housings. This construction permits the attainment of a high quality factor ($\Sigma u^2/h_0$), indicating a very high coefficient of efficiency which is made possible by the availability of a large number of stages and the use of blading of large diameter. The quality factor of the large turbines of this type running at 3000 rpm amounts in the Siemens design to from 2800 to 3000. Extensive steam-consumption tests were carried out in May, 1929, on two 24,000- to 30,000-kw turbines of this kind installed at the Gerstein plant of the United Electric Works of Westphalia at Dortmund. These tests were repeated in December, 1930, in order to obtain information as to the possibility of change of the efficiency of the turbine after a certain period of service—in this case about a year and a half. The execution of these tests was provided for in the contract for building the units and the data are reproduced in Table 1. The tests would seem to indicate an usually high degree of efficiency obtained under these conditions.

The conditions of steam at admission were at all loads in both series of tests kept approximately as per specification (20 atm pressure, 400 C = 752 F temperature) which applied particularly to the second series of tests. On the other hand, the temperature of the cooling water and degree of cleanness of the condenser, and hence the vacuum in the exhaust connections of the turbine, were materially different from contract specifications. The turbines were designed to use a vacuum in the exhaust connections of about 96 per cent at a load of 24,000 kw, corresponding to a cooling-water admission temperature of 15 C (59 F). In the 1929 tests as shown in Table 1 the cooling-water temperature was on an average 23 C (73.4 F) and in the 1930 tests only about 6 C (42.8 F). In Fig. 3 the measured steam consumption is plotted against the bus-bar output after elimination of the steam and power consumption for purposes of condensation. From the curves of Fig. 3 it would appear that the best measured steam consumptions amounted to 4.15 kg (9.13 lb) per kwhr with a heat drop of 248 kg-cal per kg (446.4 Btu per lb), and 3.96 kg (8.71 lb) per kwhr for 281.5 kg-cal per kg (506.7 Btu per lb). If the figures were adjusted for the same generator efficiency, it would be found that notwithstanding the increase in the heat head of 13.5 per cent, the improvement in steam consumption was only about 6 per cent. With the greater heat head the minimum steam consumption at a load of about 20,000 kw is some 79 metric tons per hr steam throughput as compared with 22,700 kw and 95 tons per hr at the lower heat head. The turbine therefore shows a somewhat better steam consumption with the better vacuum, but at the same time its efficiency falls off and the best value of steam consumption is found to exist at a smaller output or a smaller steam throughput, as will be shown later. These facts must be borne in mind in plotting the computation curves. It would further appear from Fig. 3 that the no-load steam consumption with the generator excited amounts to about 7.5 metric tons per hr and is independent of the amount of vacuum.

In Fig. 4 the measured efficiencies are plotted as curves *a* and *b* against the corresponding outputs at the turbine coupling. Curve *b* plotted for a lower cooling-water temperature, i.e., higher vacuum, is materially flatter than curve *a* plotted for warm cooling water. This is in good accord with the exit losses, which because of an enormously rapid increase in the specific volume of steam with rising vacuum, themselves rise at any peak point from something like 1.8 per cent to about

TABLE 1 TESTS OF LARGE STEAM TURBINE

	Tests from May 22 to 28, 1929					Tests from Dec. 8 to 11, 1930				
Generator output, kw	6440	12,625	18,610	22,700	24,690	6300	12,150	18,400	24,210	31,100
Cos φ	0.8	0.694	0.719	0.727	0.72	0.72	0.74	0.72	0.78	0.99
Steam pressure ahead of admission valve, atm	19.55	20.0	19.9	19.9	19.8	20.07	20.25	19.55	20.11	19.6
Steam temperature ahead of admission valve, deg C	374.2	389	393.8	401	395.7	388.9	400.3	405.3	402.1	404.7
Inlet temperature of cooling water, deg C	23.8	23.05	22.6	22.5	22.4	5.7	5.7	5.9	5.7	6.0
Vacuum in exhaust-steam connection, per cent	94.7	94.6	92.7	92.65	90.75	97.8	97.8	97.8	97.6	96.9
Measured steam consumption, not including condenser operation, kg per kwhr	5.285	4.385	4.3	4.15	4.38	4.754	4.203	3.963	4.043	4.15
Adiabatic heat drop, kg-cal per kg	249	252.5	246	248	239	277	280.5	281.5	279.5	271
Efficiency of turbo-generator set, per cent	65.2	77.7	81.2	83.5	82.2	65.3	72.9	77.1	76.1	76.4
Efficiency of generator, per cent	88.0	93.25	94.95	95.6	95.6	87.5	93.5	94.7	95.7	96.4
Efficiency of turbine, per cent	74.1	83.3	85.6	87.3	85.95	74.6	78	81.4	79.5	79.3
Exit loss, per cent	2	1.7	1.7	1.7	1.8	1.55	2.7	5.6	9.8	10.6

9.5 per cent. The influence of the exit loss is so great that the efficiency reaches its maximum value at a smaller throughput of steam, and the turbine appears to be designed for a smaller output.

The only means hitherto successfully used to keep down the exit losses of a steam turbine for a given quantity of steam consists in giving correspondingly large dimensions to the cross-sections in the low-pressure stages. In the turbines here investigated the cross-section of the exit in the last series of rotor blades in each of the turbines is 2 × 1.14 sq m = 2 × 12.27 sq ft. If it should be desired to cut down the exit loss with cold cooling water to one-half of the present value, it would be necessary to give the last low-pressure stage a cross-section about twice as great as what it is now. This would require an installation of another double-flow low-pressure housing with a corresponding change in the layout of the condenser. Judging by the results obtained in the present tests, if this were done and cold cooling water were used there would have been an optimum steam consumption of about 3.75 kg (= 8.25 lb) per kwhr, not counting the condenser work. High first cost would not justify the use of such a design.

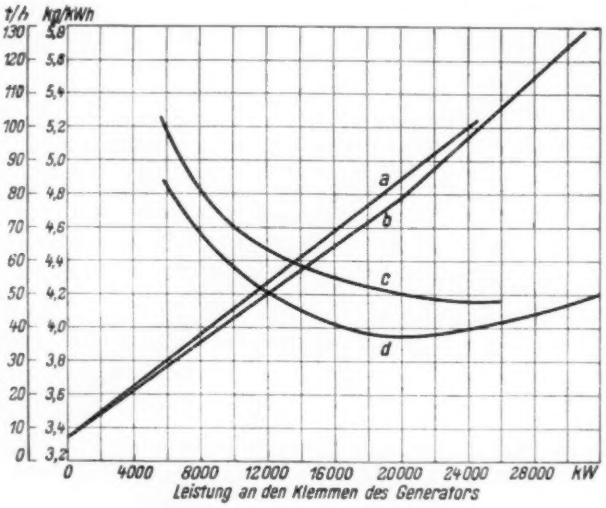

FIG. 3 MEASURED STEAM CONSUMPTION OF SIEMENS 24,000–30,000-KW TURBINE

[*Leistung an den Klemmen des Generators* = output at the generator terminals; *a*, measured steam consumption in metric tons per hr with cooling water at 23 C (73.4 F); *b*, same as *a* with cooling water at 6 C (42.8 F); *c*, measured steam consumption in kg per kwhr with cooling water at 23 C; *d*, same as *c* but with cooling water at 6 C.]

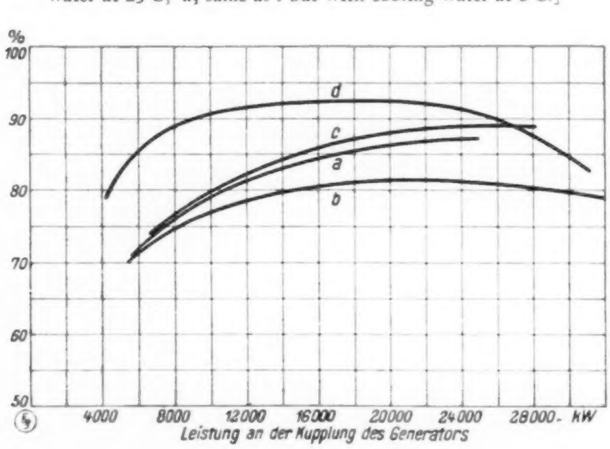

FIG. 4 EFFICIENCY OF SIEMENS 24,000–30,000-KW STEAM TURBINE

[*Leistung an der Kupplung des Generators* = output at the generator coupling; *a*, measured efficiency with cooling water at 23 C; *b*, same as *a* but cooling water at 6 C; *c*, computed efficiency for assumed zero exit loss; *d*, measured efficiency of the Kaplan water turbine at Ryburg-Schwörstatt.]

Of course, the efficiency curves *a* and *b* in Fig. 4 should not be used by themselves in estimating the quality of the turbine. In order to obtain an efficiency curve that would be suitable for such an estimation, it would be necessary to compute for each point of the curve the exit loss and add it to the proper values on curves *a* and *b*. As all the other losses in the turbine remain practically unaffected by changes in vacuum, elimination of the exit loss on the curves *a* and *b* would give a single efficiency curve. This happens to be the case. Such a curve is presented by *c* which has a value at maximum output of about 89 per cent. Of the 11 per cent of losses, 4 per cent are losses due to leakages, so that the maximum blading efficiency is 94 per cent. Curve *c* shows incidentally that the efficiency of the turbine has not been unfavorably affected to any material extent by one and a half years of continuous operation.

The author next compares the advance in steam-turbine construction with that in water-turbine construction. (Karl Dietrich in *Siemens Zeitschrift*, vol. 12, no. 7, July, 1932, pp. 238–241, 3 figs., 2 tables, *e*)

PUMPS

The Theory of the Air-Lift Pump

THE author of the present article on the theory of the air-lift pump presents a method by means of which it is possible to analyze and calculate the velocities of the air and water, the losses, and, consequently, the efficiencies of an air-lift pump. He refers to his own publication presented as a thesis for the degree of doctor of engineering at the Technical High School in Berlin in 1931, and written in German and bearing the title, "Efficiency and Fundamentals of Calculation of Air-Lift Pumps." The tests were made on equipment installed in Germany which served to pump out a mine shaft and the ore seams connected with it after they had been flooded with water. The measured values are shown in relation to each other in Fig. 2 in the original article, from which it would appear that:

1 For each submergence ratio (= depth of immersion S divided by delivery height H) the quantity of water first increases rapidly with increased air consumption and then more slowly up to a maximum, after reaching which it again falls away.

2 The quantity of water lifted also falls off with constant air consumption as the submergence ratio is reduced.

3 A very slight alteration in the submergence ratio gives very different curves for the quantity of water in relation to the air consumption, so that it is only possible to make a correct comparison between two air-lift installations if the submergence ratio and delivery height are absolutely constant.

The author derives an expression for the overall efficiency of the pump. This efficiency, corresponding to the losses due to the flow of the water and the flow of the air through the water, can be split up into two parts so that

$$\eta_{tot} = \eta_W \times \eta_A$$

The efficiency η_W is mainly determined by the losses that are caused by the acceleration of the water from rest up to the delivery velocity and the friction against the wall of the pipe. It corresponds to the hydraulic efficiency of the pumps in general, and is expressed by the ratio of the work done in

pumping against the actual delivery height H to that against a total head of $H_r = H + h$, increased by an amount h equivalent to the loss of head in the pump.

Here H is the delivery height in meters. The following expression for the efficiency is then given:

$$\eta_W = \frac{W \times H}{W \times (H + h)} = \frac{H}{H + h} = \frac{H}{H_r}$$

Here W is weight of water per second in kilograms. The efficiency η_A is mainly determined by the losses that arise due to the velocity of the air being different from that of the water. An expression for this is given in the original article in terms of absolute water velocity v_W and relative air velocity in meters per second.

Another equation given in the original article for the density of mixture of air and water shows that for an air-lift pump without losses due to acceleration and friction, the specific weight of the mixture at the upper end of the pump depends only on the delivery height H and the absolute pressure P_1, which is determined by the depth of immersion S—i.e., on the total length of the pipe. The flow resistance h can be directly calculated from two equations given in the original article; namely, Equation [14], which measures the quantities of water and air, and Equation [11], which expresses the water velocity. In the original article graphs are given showing the measurements of Hoefer of the specific mixture weights as shown in comparison with those calculated from the author's Equation [14] (not reproduced here). The agreement is very good.

The relative air velocities at the upper end of the pump are plotted in Fig. 5 against the air consumption for various submergence ratios, from which it may be deduced that:

(1) With constant submergence ratio, the relative air velocity increases with the weight of air.

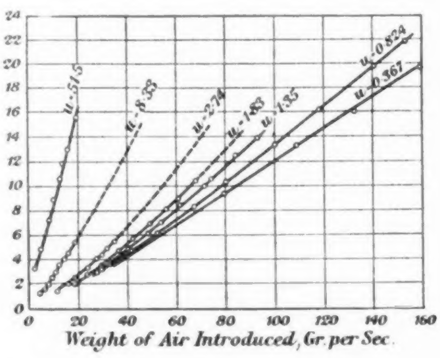

FIG. 5 RELATIVE AIR VELOCITIES AT THE UPPER END OF THE PUMP PLOTTED AGAINST THE AIR CONSUMPTION FOR VARIOUS SUBMERGENCE RATIOS

(2) With constant weight of air, the relative air velocity increases with the submergence ratio.

The relative air velocity has here values of over 20 m per sec. Reference to the remarks made in connection with Equation [5] shows that with very low efficiencies still higher relative air velocities may be expected.

In the case of a pipe having a diameter of 100 mm, as used here, the equation for the relative air velocity in m per sec becomes, with A = the weight of air in grams:

$$v_s = \frac{0.07745}{g_W - g} \times \left(\frac{A}{f}\right)^{1.23}$$

The efficiencies η_W and η_A in relation to the overall efficiency η_{tot} are shown in Fig. 6 for various submergence ratios, as determined by Davis and Weidner, on a 31.75-mm-diameter pipe, 5.89 m long, and by the author on a 100-mm-diameter pipe, 42 m long.

From this figure the following can be seen:

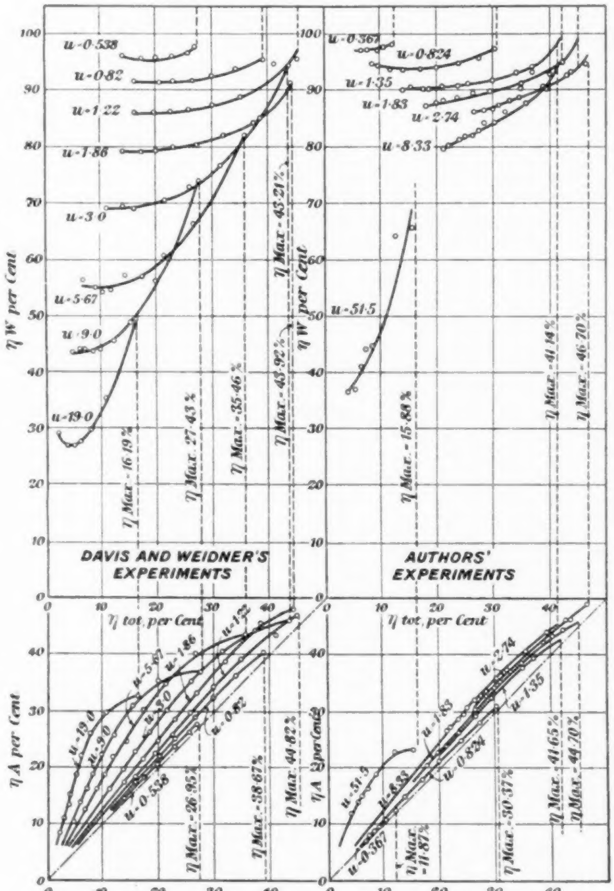

FIG. 6 EFFICIENCIES η_W AND η_A IN RELATION TO THE OVERALL EFFICIENCY η_{tot} FOR VARIOUS SUBMERGENCE RATIOS

(1) The hydraulic efficiency η_W is highest at the most favorable operating point.

(2) The slip efficiency η_A is nearly equal to the overall efficiency with low values of the submergence ratio.

(3) The relative air velocity reduces the overall efficiency to a greater extent than do the pipe frictional losses.

(4) The frictional losses in the pipe approach an approximately constant value at high loads.

(5) With a constant length of pipe, the frictional losses in the pipe become greater in proportion to the effective work as the submergence ratio increases.

(6) With a constant length of pipe, the losses due to the relative air velocity become greater in proportion to the effective work as the submergence ratio increases.

(7) With constant submergence ratios, the frictional losses in the pipe are greater with small than with large pipes.

(8) With constant submergence ratios, the relative air velocity in small pipes is smaller than in large ones, which is also the case in water volumes at rest.

(F. Pickert, Doctor of Engineering, in *Engineering*, vol. 134, no. 3468, July 1, 1932, pp. 19–20, *etA*)

RAILROAD ENGINEERING

Air Conditioning of Trains on the C. & O.

IN THE air conditioning of trains on the Chesapeake & Ohio, the cooling system operates intermittently under thermostatic control. Excess moisture is removed from incoming air by condensation on the cooling coils, and dry air, when heating, is humidified by means of a small steam jet automatically controlled.

A unique feature of the air-conditioning system in the "George Washington" train cars is the method of power development and transmission. For precooling, when the train is standing at yards or stations, the only type of power required is provided by a standby motor that can be plugged into any convenient source of electric power at 220 volts. When the cars are in motion, power for operating the system is transmitted from one of the truck axles without the employment of electric generator and motor. No additional storage-battery capacity is needed with this system, as the only power requirement not provided for in the main drive is for a small $^3/_4$-hp electric motor that drives the fans for the main air-circulation system and takes current from the car-lighting battery.

As regards the power drive, the most interesting feature is the electrical speed control which functions on the principle of electric induction and possesses the unique feature of starting the compressor when the train speed reaches 5 mph, increasing the compressor speed up to a maximum of 350 rpm at about 35 mph and holding it at that point regardless of subsequent higher train speeds.

The governor within the electric speed control regulates the amount of current flowing through the windings of the field coil, thus limiting the drive to a predetermined speed. As train speed is reduced to a point where the generator relay is out of circuit, a shock-relief relay coil is de-energized and the induced current generated in the electric speed control is discharged through the resistance in the field circuit. When the cooling thermostat breaks the electric circuit, de-energizing the shock-relief relay coil, the electric speed control ceases to turn the compressor until the temperature rises, again closing the circuit. (*Railway Mechanical Engineer*, vol. 106, no. 5, May, 1932, pp. 173–176 and 190, illustrated, *d*)

Semi-Water-Tube Firebox on the B. & O.

A NEW type of semi-water-tube firebox has been applied to a number of heavy-type locomotives on the Baltimore & Ohio. The semi-water-tube firebox can be installed inside the conventional firebox of stayed construction with or without a combustion chamber. The firebox announced was developed to obtain a material addition to the heating surface from existing fireboxes. As shown in the illustration, Fig. 7, it consists of two troughs about 16 in. deep which extend longitudinally in the firebox and are welded to the crown sheet. The bottom of each trough is connected to the side water legs of the firebox by a number of circulating tubes. These tubes are rolled and beaded in both the side sheets and the troughs.

This semi-water-tube firebox effects a marked increase in direct firebox heating surface. The heating surface on the 2-8-2 type locomotive on which the first installation was made was originally 256 sq ft. With the semi-water-tube firebox, an additional 74 sq ft of heating surface was acquired, making a total of 330 sq ft. The former firebox, by Cole's ratios, evaporated 14,056 lb of water per hr, while the semi-water-tube firebox is capable of evaporating 18,173 lb of water per hr, or an increase of 29 per cent.

Before conversion the firebox shown in the drawing had a heating surface of 327 sq ft, including the combustion chamber. After the semi-water-tube firebox was applied, the heating surface was increased to 432 sq ft. The evaporation with the original firebox, calculated according to Cole's ratios, was 18,004 lb of water per hr, and after the semi-water-tube firebox

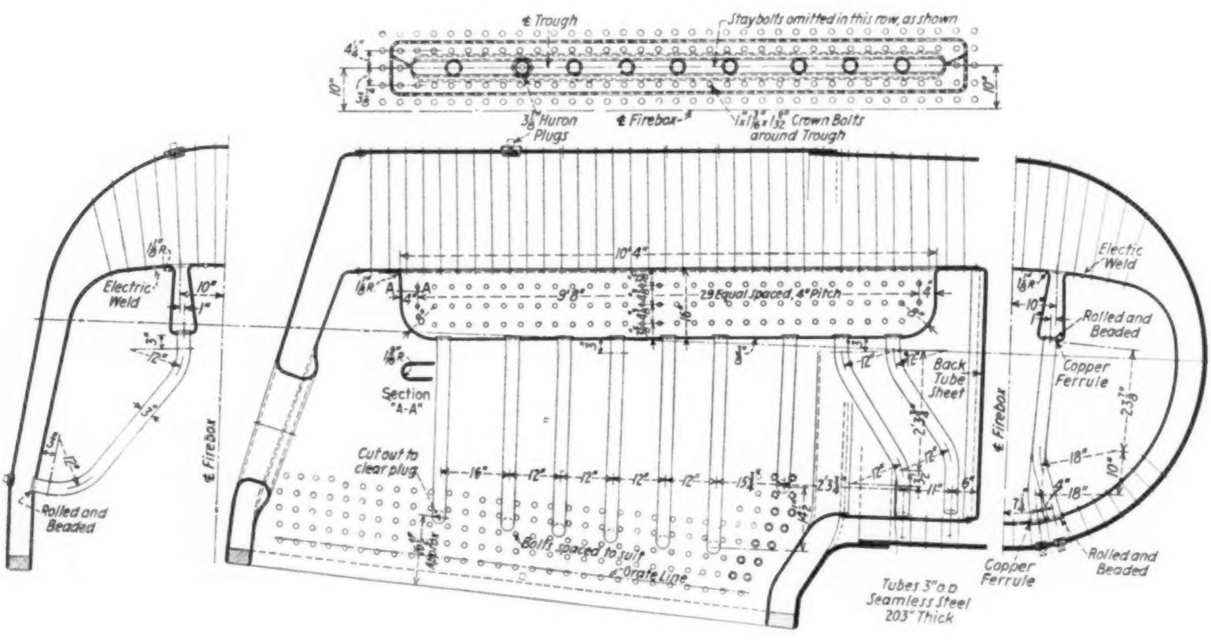

FIG. 7 SEMI-WATER-TUBE FIREBOX DEVELOPED BY THE B. & O.

was applied, 23,793 lb per hr, or an increase of 32 per cent.

Besides increasing the direct firebox heating surface, the semi-water-tube firebox increases the circulation in the side water legs of the boiler and is expected to prolong the life of the side sheets and staybolts. The rapid circulation set up by the semi-water-tube firebox will also act as a safety measure for the crown sheet. A rapid upward circulation is set up, which will prevent the crown sheet from being pulled away from the staybolts. (*Railway Mechanical Engineer*, vol. 106, no. 5, May, 1932, pp. 188-189, illustrated, *d*)

A New 4-8-2 French Locomotive

FORTY four-cylinder compound superheated express locomotives of the 4-8-2 type, and which is claimed to be a new design, have been placed in service on the Eastern Railroad in France. The first of these locomotives was built entirely in the company's shop, while the others were constructed outside. The locomotives have two high-pressure cylinders driving the second coupled axle, and two low-pressure inside cylinders driving the first coupled axle. The Walschaerts valve gear is characterized by the use of piston valves with a long travel even at early cut-offs. This feature insures large steam passages, and therefore reduces wiredrawing during admission and particularly during exhaust. It is claimed that these long-stroke piston valves give the same advantages as poppet valves actuated by oscillating cams.

The coupling gear between locomotive and tender is of a new type, referred to as "systeme M," and contains no springs. A hollow pin 180 mm ($7^3/_{32}$ in.) in diameter is mounted vertically in bearings at the rear end of the locomotive. Up and down this pin there can slide freely a spherical piece having a seating in the shackle attached to the drag box of the tender. The combination thus consists of a ball-and-socket point sliding on a vertical pin and gives freedom of motion in all directions. Besides allowing for differences of height, inclination, and direction between the locomotive and tender, this coupling has the further great advantage that the locomotive footplate can be extended over the front of the tender, thus providing a single floor in the cab and eliminating the inconvenience and fatigue that result from working on the two footplates subject to wide and irregular movements with regard to each other. The type-M coupling is now fitted to more than 250 locomotives on the East system and makes possible the interchange of tenders coupled to these machines.

The service performance is said to have been good. Twelve consecutive runs were made at an average speed of 59 mph, with trains ranging in weight from 566 to 679 tons.

The theoretical tractive effort of the locomotives is 29,900 kg (65,930 lb), this being calculated from the following formula used by the company for their four-cylinder compound locomotives:

$$F = \frac{2Pd^2l}{D}.$$

where F = tractive effort, in kg; P = boiler pressure = 20 kg per sq cm; d = diameter of high-pressure cylinders = 45 cm; l = stroke = 72 cm; D = diameter of coupled wheels = 195 cm.

The eight-wheeled, double-bogie tender, the principal features of which are shown by an accompanying drawing, is of the T. I. (tender-interchangeable) type, with the M-type coupling already described. It is one of a series of 82 belonging to heavy express locomotives engaged in long-distance non-stop runs. An essential complement to the M-type coupling is the lateral displacement of the leading bogie on either side of its central position under the control of restoring springs, as in the locomotive bogies and bissel. When a T. I. tender is coupled to a locomotive which has no trailing axle, the leading bogie and restoring spring of the tender facilitate the running of the locomotive on curves. The strict enforcement of a system of tolerances in the construction and maintenance of the component parts of the couplings insures that any T. I. tender can at once be coupled to any T. I. locomotive. (*The Railway Engineer*, vol. 53, no. 629, June, 1932, pp. 225-228, and one large plate of drawings, illustrated, *d*)

REFRIGERATION (See Railroad Engineering: Air Conditioning of Trains on the C. & O.)

STEAM ENGINEERING (See Motor-Car Engineering: One-Man "Sentinel" Steam Wagon)

TEXTILE INDUSTRIES

New Ideas in Wool Scouring, Milling, Shrinking, and Finishing

ANIMAL fibers, such as wool, are peculiar among textile fibers in that they possess a surface scale structure. This outer layer of overlapping scales is far more resistant to chemical attack than the interior of the fiber, and in order to process wool without undue damage thereto, it is necessary that this scale layer shall be preserved intact. Moreover, when fibers are twisted together with form yarn, they are necessarily brought into very intimate contact with one another. With wool fibers, such contact is limited to point contact at the projecting edges of the scales, leaving between neighboring fibers a minute film of air, which improves the warmth of a wool fabric by reducing its conductivity.

The scale structure is also directly responsible for the milling process. Milling, too, is an essential preliminary to raising, and by means of these two processes it is possible for a given weight of material to produce fabrics of great comparative thickness with wool, this being a second reason for the superior warmth of wool fabrics. Unfortunately, the increased thickness obtained by milling and raising is obtained only at the expense of a reduction in area of the fabric—i.e., shrinkage. With untreated fibers this power of shrinkage is always present, and will always exert itself whenever a fabric is laundered. This is naturally a serious defect, particularly in hosiery goods, and the so-called "unshrinkable finish" has been devised to meet the difficulty. In this finish, having used the scales to produce the type of fabric desired, they are then rendered inoperative and the nature of the fabric made permanent. Unfortunately, in treating wool so as to make it unshrinkable in this way, the scales and the underlying cortex of the fibers are damaged to a greater or less extent, according to the severity of the process, and something of the protective action of the scales against damage by ordinary wear is lost.

Scouring of wool is usually carried out by means of alkaline solutions, such as soap and/or soda. Recent research carried out by Doctor Krais, of the German Textile Research Association in Dresden, has, however, shown conclusively that although certain alkaline solutions may cause damage to wool which is in itself barely measurable, this incipient damage is subsequently developed and accentuated during dyeing. To realize the best wearing properties of a fabric, it is imperative that the protective scale layer on the fibers shall be preserved intact; and it is therefore necessary to know the exact point at which incipient damage is caused by alkaline solutions.

It is now possible to define the exact point in the action of acids and alkalis where damage to a fiber may occur, and this is being done by determination of the hydrogen-ion concentration (pH values).

As far as raw-wool scouring is concerned, the solution of the dilemma is to be found in the adoption of suint scouring. In this process the wool is cleansed by means of the suint (sweat) which it normally contains, and the pH of a suint scouring liquor is stated to be 7.2 to 7.8, within the stability region. For the scouring of yarn or woven fabrics the difficulty can be solved by the use of the modern synthetic soaps, such as Igepon A, which dissolves in water to give a solution of pH = 6.5. The use of suint and Igepon A has other important advantages. As will be indicated later in the paper, the felting of wool and the shrinkage of fabrics are at a minimum within the stability region defined. Thus, in raw-wool scouring, the felting will be least and the production of noil least when suint scouring is employed. Further, by performing scouring within the stability region, the wool is obtained in an undamaged condition—i.e., in the best possible condition for the subsequent carding, combing, and spinning operations.

Since milling requires the use of strongly acid or strongly alkaline solutions, it may be asked what good do the elaborate precautions against excessive chemical action in wool scouring do when the wool is to be exposed at a later stage of manufacture to far more drastic conditions. At least one important reason so far as raw-wool scouring is concerned is that the wool behaves best in carding, combing, and spinning when it is undamaged.

The next process to be considered is that of milling. It is the most fundamental of all wool textile processes. As a result of a detailed study in the textile-chemistry laboratories of Leeds University of the various aspects, it is now possible for the first time to give a complete explanation of every feature of milling shrinkage. The work has indicated a totally new possibility for making wool unshrinkable, dispensing with the chlorination process which is so likely to cause undue damage to wool.

Milling can be applied only to fibers which possess a surface scale structure. The exact manner in which the scales promote milling shrinkage may be deduced from the experiments of Ditzel (*Deutsche Wollen Gewebe*, 1891, No. 1). He showed that when fibers are subjected to longitudinal rubbing action they tend to travel in the direction in which the scales do not oppose motion—i.e., in the direction of the root end. For example, when two locks of wool were placed end to end, their root ends in contact, the action of the felting machine caused rapid interpenetration of the fibers from each lock, whereas when the tips were in contact no interpenetration could be observed. It seems clear from experiments such as these that the fibers composing a wool fabric will similarly tend to travel in the direction of their root ends under the action of the milling machine. The great penetrative power possessed by wool fibers is well illustrated by a discovery made by Dr. J. I. Hardy in the Leeds laboratories. After soaping a lock of wool, he enclosed it in a chamois-leather bag, and subjected the latter to the action of a milling machine. When the bag was subsequently opened and examined, it was found that the fibers had penetrated the leather, the whole lock of wool being firmly attached to the bag. It remained for Shorter ("J.S.D.C.," 1923, 39, 270) to show that such undirectional freedom of motion of fibers can cause the shrinkage of fabrics. His explanation is, briefly, that fibers traveling in the direction of the root end can carry along with them those fibers with which they are mechanically entangled. Under the action of the milling machine there will therefore be a continuous tightening up of the structure, with decrease in its surface area and increase in thickness as a result. On the basis of this view of shrinkage it would be expected that the rate of shrinkage of a fabric in a milling machine would be determined by the magnitude of the difference between the frictional resistance to motion of a fiber in the direction of the root end, and that in the direction of the tip, the friction being greater in the latter instance. In the absence of complicating factors, this difference in friction and the rate of shrinkage should be directly related. Measurements of the scaliness of different wools were therefore undertaken. The method consisted briefly in constructing a kind of violin bow from wool fibers arranged parallel to one another with their scales all pointing in one direction.

Values for the scaliness of different wools have been obtained and are in good agreement with recognized milling properties.

The matter of external conditions of milling is considered next. This part covers the effect of acidity and alkalinity of the milling agent, which includes the matter of swelling of wool fibers.

The chlorination process for imparting the unshrinkable finish to wool goods is briefly covered. The author believes that the real reason for the success of the process is that the chlorine attacks the layer of the cortex immediately underlying the scales and makes it extremely susceptible to attacks by alkaline reagents, as has been stated by Speakman and Goodings.

On treatment with soap or soda after chlorination, the attacked cortex is converted into a jelly which is located between the scales and the unattacked cortex. In other words, when the liquor is sufficiently alkaline for milling shrinkage to occur, the scales are only very loosely attached to the fiber, and under the action of the milling machine they are themselves removed instead of promoting shrinkage when stretched fibers contract. The presence of scales is, however, necessary for good wearing properties, and chlorinated wool must therefore be somewhat defective in this respect. The difficulty is all the more accentuated by the enormous affinity of wool for chlorine, which causes very irregular adsorption of the reagent, and in extreme cases intense local damage to the fibers. Careful manipulation may overcome the difficulty to a very large extent, but there can be no doubt that the housewife's opinion of chlorinated wool is definitely critical.

On the previous indefinite views as to the nature of milling shrinkage there appeared to be no way of escape from the dilemma to prevent shrinkage: either the scales must be eaten away or else temporarily detached from the cortex, both methods causing inferior wearing properties. The new view of milling shrinkage suggests another alternative. For milling shrinkage to occur, a fiber must possess two properties—it must have a surface scale structure and it must be perfectly elastic. There are thus two ways of making wool unshrinkable: either to make the scales inoperative as in existing processes or to make the fiber imperfectly elastic. In the latter case the fiber would not be made permanently inelastic or the fabric would lose its characteristic handle and appearance. What is required is some reagent which can be added to a scouring medium to make the fibers temporarily inelastic while laundering is carried out, the reagent being washed out when the fabric is clean and perfect elasticity restored. If such a reagent can be found, it would be a great boon to hosiery manufacturers and launderers in particular. It would confer an enormous benefit on the wool trade by removing the stigma of inferior wearing properties from hosiery goods in particular. (J. B. Speakman in *American Dyestuff Reporter*, vol. 21, no. 7, March 28, 1932, pp. 214–216 and 235–236, 2 figs., *gd*)

SYNOPSES OF A.S.M.E. PAPERS

THE papers abstracted on this and following page appear in the current issues of the Aeronautical Engineering, Management, and Wood Industries sections of A.S.M.E. Transactions, or are available on request in mimeographed form. These sections have been sent to all who registered in the similarly named Divisions. Other sections are in the course of preparation and will be announced, when completed, in later issues of "Mechanical Engineering." Copies of the Transactions papers may be obtained by those not registered in these Divisions by addressing the Secretary of the A.S.M.E., 29 West 39th Street, New York, N. Y.

AERONAUTICS

The Controllable-Pitch Propeller

DESPITE seeming advantages, the controllable-pitch propeller has not come into general adoption, there having been four principal reasons given, these being the lack of proved safety and dependability and the excessive weight and maintenance and cost. There is now being introduced a type of controllable-pitch propeller in which an effort is made to reduce the causes of former objections. The new blades are made of magnesium alloy and are semi-hollow, the inner ends being bored out and the outer ends remaining solid. For the commercial operator the greatest improvement in performance on single-engine planes will be in take-off and climb and in fuel economy in cruising. With multiple-engine planes the controllable-pitch propeller, in connection with geared engines of extremely high speed, will make it possible to fly with one engine out of commission. (Mimeographed paper, by Frank W. Caldwell.)

Magnesium and Hollow-Steel Propellers

A STUDY of the hollow-steel propeller is set forth in impartial fashion for the use of designers when considering the selection of a propeller for their planes. There is a comparison of hollow-steel propellers and propellers of other materials such as magnesium. In a hollow-steel propeller the saving in weight with either magnesium or steel is especially conspicuous in the large diameters, and there will be corresponding reductions in the inertia and gyroscopic forces. The hope is expressed that minimizing the objections to large propellers will aid the movement toward geared engines, with the benefits of higher engine speeds, lower tip speeds, and improved efficiency, economy, and performance. (Mimeographed paper, by G. T. Lampton.)

The Aviation Course at the Naval Academy

EFFORTS have been made to make the aviation service independent of the Navy, and the paper gives reasons why this should not be done. The primary mission of naval aviation is to support, expand, and supplement the operations of the surface forces of the fleet. Plans are suggested for the amplification of aviation subjects in the training at the Naval Academy. A department of aeronautics, if established, could combine the various elements that now form a part of the aviation training syllabus. (Mimeographed paper, by Lieut.-Com. D. C. Ramsey.)

Ludington Line Operations

DATA on air-line operation and costs are given. In fixing rates the usual custom of adding a profit to the predetermined operating cost was disregarded, and a price was established based on ground-transportation rates. Then operating costs were formulated that permitted this low tariff, the operating costs being reduced one-half. Planes should carry 10 passengers. Increased speed as an aid in cutting operating costs will open the door to lower fares and to an unprecedented volume of traffic, permitting air transportation to rival other forms. (Mimeographed paper, by Paul F. Collins.)

The Tail Spinning of Aircraft

TAIL SPINNING of aircraft is a subject of interest to manufacturers and operators alike. There is much to be learned in the application of corrective measures. The problem was investigated by the Department of Commerce, and it was determined that there were four factors which in most cases will determine if an airplane will have satisfactory spinning characteristics: It should be stable about all three axes; the center of gravity should be well forward with respect to the center of pressure; the wing loading should be kept below a certain maximum figure depending mostly upon the characteristic of the particular airfoil; the weights of airplane and cargo should be grouped as closely as possible around the center of gravity. One or more of these characteristics were involved in every airplane that spun unsatisfactorily, and the correction of this factor brought about the desired result. (Paper No. AER-54-10, by Gilbert G. Budwig.)

Water-Recovery Apparatus for Airships

IN ORDER to operate efficiently, an airship must maintain an approximate equilibrium of its weight and buoyancy. Since the former is progressively reduced when liquid fuel is burned, some other means than valving the costly lifting gas, helium, must be employed to compensate for the weight of the fuel consumed. The author states five alternative means, and then briefly outlines the work done in developing one of them—recovering water for ballast from the engine exhaust, following which he sets forth the theory of such water recovery, accompanied by illustrative examples. The desirable features of a water-ballast collector are then dealt with, and the paper concludes with brief notes on the principles of design and construction of the apparatus and on recent developments in ballast collectors. (Paper No. AER-54-11, by C. P. Burgess.)

MANAGEMENT

Coordination of Research and Engineering With Production and Sales

LARGELY an exposition of the organization of the Bausch & Lomb Optical Company, Rochester, New York, in so far as it affects the function of research and engineering, the paper

shows how this company went through a thorough reorganization several years ago and was fortunate in being of sufficient size to justify a distinct research and engineering division, and still small enough to make it possible to tie the functioning of these departments to that of the other departments without becoming involved in too much machinery and red tape. The company employs about 3000 people and has a research and engineering force of about 100. It manufactures a very large variety of small-quantity-production items although there are a few items that are manufactured on what might be considered a quantity-production basis. It has, naturally, tried to minimize the amount of development work on articles that are expected to be sold in small quantities; still experience shows that quantity can have no great influence on the thoroughness with which the development work must be done, the company being often forced by circumstances to spend large amounts on work which will never result in large production. Although the Research and Engineering Department assumes full responsibility for development work, sales and production are very definitely tied into the picture and must assume part of the responsibility when manufacture is finally started. Effective means are used to bring this condition about. (Paper No. MAN-54-4a, by Carl L. Bausch.)

Coordination of Research, Sales, and Production

A DEMONSTRATION of how the various research activities are coordinated one with another, and then as a unit with sales and production, so as to consider related factors in the instigation and carrying forward of research projects, is attempted in this paper. Likewise it aims to bring out how definite mechanisms of coordination may be established whereby the greatest benefits may be derived from the research activities through the development and manufacture of products which are both commercially and technically sound. (Paper No. MAN-54-4b, by Richard F. Wilder.)

Dividend Programs Related to Depreciation

FIGURES are presented to show the working out of five selected dividend programs and to demonstrate that depreciation funds can be and often are misused as a result of the dividend program chosen. Several related subjects also are discussed, such as historical statements for interpretation of results, possibility of a current investment to current liability ratio, dividends that return parts of the original investment, and depreciation funds spent by management. (Paper No. MAN-54-5, by E. G. Field.)

WOOD INDUSTRIES

Studies in the Design of Local Exhaust Hoods

FAILURE of many local exhaust systems properly to control industrial dust hazards may be attributed, in part, to the lack of sufficient knowledge of the factors governing the collection efficiency of various types of goods. The present study was undertaken in an effort to obtain data on the aerodynamic characteristics of simple geometric suction openings which may serve as a basis for future studies of the problem of design of local exhaust systems. Round, square, and rectangular openings were investigated and their aerodynamic characteristics are expressed by means of velocity contours or lines of equal velocity. Contour lines were found not to be influenced by the total airflow through the hood. They did not differ in their chief characteristics with the geometric shape of the opening, although rectangular openings exhibited a flattening of their contours that varied with the ratio of the sides. An increase in the area was found to cause a displacement of contour lines at right angles to the axis of the opening. Along the axis, however, velocities coincided at distances of 6 in. or more from the face of the hood. Gross characteristics of suction openings, it was found, could be expressed by means of center-line velocity curves. These curves, which are obtained with less labor than are the velocity contours, may be compared graphically and also mathematically. Simple charts are presented and mathematical equations were obtained for the three types of openings that may be used within the zone of hood influence. (Paper No. WDI-54-10, by Joseph M. Dallavalle and Theodore Hatch.)

Double-End Tenoners and Their Use

IN THIS paper are described the construction, development, and use of the double-end tenoner from the original belt-driven machine with babbitted bearings, with its limited range of cutting stock to length and making tenons, to the present motorized ball-bearing machine, with its broad range of sizing, tenoning, shaping, dadoing, relishing, notching, and dovetailing all rectangular parts in two passes through the machine, and the making of certain styles of lock joints. It is by far the nearest to a universal-use machine yet developed for a production wood-working plant. (Paper No. WDI-54-11, by J. H. Mansfield.)

Developing a New Wood Product Through Research

MANY appeals have been made before the Wood Industries Division for research, and several papers have been presented, particularly that of Dr. J. W. Lawrie, in October, 1930. The development of a new prefinished plywood flooring is covered in detail, beginning with the product selection and discussing competitive products of both solid wood and nonwood. Considerable attention is given to the principles of market analysis, although it is admitted that the present depression renders such investigation of less than usual value. Detailed consideration is given to product analysis, emphasizing the limitations and shortcomings of available wood floorings. This analysis is followed by the respective and corresponding steps required to overcome these shortcomings. Practical or applied research is the basis for all the solutions. Emphasis is placed on the strength and rigidity qualities of plywood as well as on the manifest advantages of prefinishing. Several unanticipated advantages appeared from time to time among the research steps. In conclusion it is pointed out that the development of this plywood flooring, from its inception to its acceptance by the market, has been accomplished in an unusually short time, and therefore offers encouragement to other woodworkers to do likewise in their field. (Paper No. WDI-54-12, by Thomas D. Perry.)

Aluminum Oxide Versus Garnet as a Wood Abrasive

COMPARISON is made of aluminum oxide and garnet as surface-coated abrasives in woodworking. Garnet as found in the native state breaks into wedge-shaped pieces that when cemented to a surface of paper or cloth continue to fracture so as to produce further sharp edges. Aluminum oxide is a manufactured product, made in the electrochemical furnace by fusing bauxite and adding coke and iron. The hardness, toughness, and fracture of the two abrasive materials are compared. A table is given that covers time-study tests of belts used in a woodworking plant, with the labor and material costs. (Paper No. WDI-54-13, by J. F. Traendly.)

STANDARDIZATION—CODIFICATION

Notes on Work of Technical Committees of the A.S.M.E., Etc.

Standardization

The Standards Yearbook

THE "Standards Yearbook" for 1932,[1] compiled by the Bureau of Standards, has recently been issued by the Superintendent of Documents. This is the sixth year in which this work has been published.

A special feature of the present volume, constituting the first chapter, is a series of articles contributed by experts in numerous fields of communication. These cover such diverse subjects as radio, aeronautical communication, television, acoustics, traffic signals, and language. Other chapters are devoted to international standardizing agencies, the organization and work of the eight governmental national standardizing laboratories, a description of national industrial standardizing bodies, which now exist in eighteen countries, and another of the standardization functions of the bureaus of the several government departments.

The concluding chapter contains sketches of the activities of scientific and technical societies, trade associations, and other agencies, and attempts to present in condensed form a picture of the standardization movement in the various lines of industry conducted by these organizations. In these outlines, 416 in number, particular attention has been paid to current standardization programs and to accomplishments to date, with special reference to the year just past.

Directory of Commodity Specifications

THE Government Printing Office has just issued the first revision of the "National Directory of Commodity Specifications"[2] originally published in 1925. This volume consists of classified and alphabetical lists and brief descriptions of specifications having national recognition. It represents an attempt on the part of the Department of Commerce to collect and publish a classified list of standards and specifications formulated to date by the national technical societies, the trade associations having national recognition, and other organizations which speak for industry or with the authority of the Federal Government as a whole.

Ten major divisions were used in the classification, comprising: Animals and Animal Products; Vegetable Food Products; Other Vegetable Products; Textiles; Wood and Paper; Non-Metallic Minerals; Metals and Metal Products; Machinery and Vehicles; Chemicals and Allied Products; and Miscellaneous.

The Directory has been prepared with the point in view of making reference to the specifications on any particular commodity both easy and rapid. The summarizing items help the reader to visualize the particular application of the individual specification and the technical characteristics covered so that a selection of those specifications which most nearly fit his particular needs is possible.

In a similar way the Directory should prove indispensable to the purchaser who uses specifications. It gives him a ready reference to those specifications which are not only well known and widely used throughout the country, but which also represent the combined experience of user and producer and in which controversial, ambiguous, and unimportant requirements have largely been eliminated.

A comprehensive index covering sixty-seven pages greatly increases the utility of the work. In addition to listing in detail the materials and products, the specifications of which are described in the text, full instructions are given for securing copies of desired specifications.

Effective Lantern Slides

EVERY one who has attended lectures or technical sessions of professional societies where charts in the form of projected lantern slides were used, has experienced at some time a realization of the complete uselessness of much of the effort expended on this method of communicating ideas and data. This reaction results from the fact that all too often no care is taken to insure the legibility and appeal of these charts. At most, these images can be held on the screen for only two or three minutes, so they must tell their story within that period if their cost in time and materials is to be justified.

For some time the members of the A.S.M.E. Standardization Committee have realized the great need for improvement in the technique of presenting technical data to audiences of various sizes through the medium of lantern slides, and have conceived the possibility of setting up a set of standard rules for drawing the original charts and for their reproduction as lantern slides. This aid to the understanding of technical papers has met with a hearty and favorable response on the part of the A.S.M.E. Meetings Committee, since it is in line with that Committee's efforts to further improve the manner of presenting papers before the Society.

The Subcommittee on Scientific and Engineering Graphs, W. A. Shewhart, Chairman, was requested to undertake the formulation of a set of standard rules for the production of lantern slides. This is a subdivision of the Sectional Committee on Standards for Graphic Presentation which was organized under the procedure of the American Standards Association with The American Society of Mechanical Engineers as sole sponsor. This invitation was accepted and a subgroup consisting of Messrs. H. F. Dodge, Chairman, C. D. Hanscom, and L. Stone was named to draft the original proposal.

Over a period of eighteen months the successive drafts of this proposed American Recommended Practice were prepared and distributed to interested individuals and groups for criticism and comment. During the December, 1931, Annual Meeting of the A.S.M.E. the Subcommittee held an open session at which this proposal was thoroughly discussed. The suggestions for changes and additions to the proposed set of

[1] "Standards Yearbook," compiled by the U. S. Bureau of Standards, U. S. Government Printing Office, Miscellaneous Publication No. 133, 1932. Cloth, $5^3/_4 \times 9$ in., 394 pp., $1.

[2] "National Directory of Commodity Specifications," First Revision. Prepared by Division of Specifications of the U. S. Bureau of Standards. U. S. Government Printing Office, Miscellaneous Publication No. 130, 1932. Cloth, $10^3/_8 \times 7^1/_2$ in., 548 pp., $1.75.

standard rules which resulted from this publicity were helpful, and the Committee completed a final draft which has since been approved and designated as an American Recommended Practice by the American Standards Association.

Copies of this recommended practice are now available in pamphlet form in single copies and quantities on application to The American Society of Mechanical Engineers.

Power Test Codes

Test Code for Centrifugal Compressors, Exhausters, and Fans

THE Individual Committee which developed this draft of the Code consists of Messrs. A. T. Brown, Chairman, W. H. Carrier, L. E. Day, E. S. Dean, Z. G. Deutsch, P. E. Good, H. F. Hagen, H. D. Kelsey, A. Peterson, and M. C. Stuart. It is believed that in its present form this Code meets the needs of all groups which from time to time have a part in the making of acceptance tests of this type of apparatus.

This Code provides standard directions for conducting and reporting tests on centrifugal compressors, blowers, fans, and exhausters. All such machines are distinguished by the characteristic that a pressure rise is produced in air or gas by means of an impeller with centrifugal or velocity actions, and always with an open passage between the inlet and the discharge. There is no clear line of demarcation between the machines known commonly as centrifugal compressors, blowers, and fans. They are subject to the same physical laws, but due essentially to the low pressure rise generated by fans and blowers, differences in the methods of testing have developed. For purposes of this Code, machines for compressing air or gas are classified as follows: Class 1—Centrifugal or turbo-compressors, blowers, or exhausters, hereafter referred to as "Compressors and Exhausters." Class 2—Centrifugal fans, fan blowers, or exhausters, hereafter referred to as "Fans."

In general, machines included within Class 1 are defined as those which, if used to compress air initially at standard atmospheric conditions, would increase the pressure by more than one pound per square inch. For such machines the formulas used in computing performance and test results must take into account the variation in density of the air or gas during compression.

Machines included within Class 2 are defined as those which, if used under similar conditions, would increase the pressure by not more than one pound per square inch. For these machines the formulas may take no account of the variation in density during compression.

Many of the methods described in this Code apply equally well to both classes of machines. In any case of doubt as to the class to which a given machine should be assigned for purposes of test in accordance with this Code, agreement on this point should be made in advance of the test.

The record sheets for data and results of the test apply to complete units, including the driver, but the Code itself applies only to the test of the compressor, exhauster, or fan.

Part 1 is a complete test code for compressors and exhausters. Part 2 consists of a complete code for fans with suitable references to those parts of Part 1 which are common to both classes of machines.

The purposes of a test of a compressor, exhauster, or fan consist in the determination of all or some of the following essential quantities, reduced to the contract conditions:

1 The inlet and discharge pressures, expressed as total pressures. The units for these quantities are usually inches of water for fans and pounds per square inch for compressors or exhausters.

2 The quantity of air or gas compressed and delivered, expressed in units of volume per unit of time, under the contract conditions of density, temperature, and pressure at the intake of the machine. The unit for this quantity is usually cubic feet per minute.

3 The power applied to the shaft of the compressor, exhauster, or fan. The unit for this quantity is usually the horsepower.

4 The rate at which steam, electrical energy, or fuel (depending upon the method of drive) is consumed by the driving element. The unit for this quantity is usually pounds of steam per hour, kilowatts, or pounds of fuel per hour. This may also be expressed as the pounds of steam, kilowatt-hours, or pounds of fuel per 100 cu ft of air or gas as contract inlet conditions.

Realizing that the measurement of the quantity of air or gas discharged from these auxiliaries, item (2) above, is of great importance, the Committee has given special attention to the development of this section of the Code.

The Code is supplemented by numerous figures and tables. The former show the proposed standard shape and method of installation of flow nozzles as well as diagrams for the correct attachment of the static- and impact-pressure indicating manometers for the numerous cases which develop when apparatus of this kind is set up for test. The latter include discharge coefficients and other constants necessary in the computations of these tests.

The Committee on Power Test Codes was organized by the Council of the A.S.M.E. in 1918 to revise and enlarge the Power Test Codes of the Society published in 1915. This Committee consists of a Main Committee of 25 members under the chairmanship of Fred R. Low, and 20 individual committees of specialists who are drafting codes for the various prime movers and the other auxiliary and related apparatus which constitute power-plant equipment.

Instruments and Apparatus—Optical Pyrometers and Flue-Gas Analysis

CHAPTER 8 of Part 3, "Temperature Measurement," on "Optical Pyrometers," and Part 10, on "Flue-Gas Analysis," are about to be presented to the A.S.M.E. Committee on Power Test Codes and the Council for approval. Before taking this step, however, the Committee on Power Test Codes is calling these sections of "Instruments and Apparatus" to the attention of the public in general.

The Committee in charge of this part of the Power Test Codes activity consists of Messrs. C. F. Hirshfeld, Chairman, W. A. Carter, Secretary, C. M. Allen, E. G Bailey, L. J. Briggs, C. R. Cary, J. D. Davis, R. E. Dillon, F. M. Farmer, J. B. Grumbein, W. H. Kenerson, E. S. Lee, E. L. Lindseth, O. Monnett, S. A. Moss, E. B. Ricketts, and W. A. Sloan.

In the chapter on optical pyrometers will be found sections dealing with fundamental principles, types of optical pyrometers, methods of use, advantages and disadvantages of the various types, range and accuracy, installation, precautions, and calibration and checking. The measurement of high temperatures by means of radiation pyrometers is based on the well-known fact that the intensity of the radiation emitted by a hot object increases as its temperature is raised. If the measuring instrument totalizes the heating effect of all the radiation that it receives from the object, the temperature of

which is being measured, it is known as a "total-radiation pyrometer," while if it measures the intensity or "brightness" of the radiation received from the object in a narrow band of the visible spectrum, it is an "optical pyrometer." It is the construction and use of the second of these types, the optical pyrometer, which is treated in this section.

Authentic methods which are in general use or are recommended by the reliable authorities for making analyses of flue gases and exhaust gases from internal-combustion engines, are discussed in "Instruments and Apparatus," Part 10, on "Flue-Gas Analysis." Complete combustion of the fuel in a furnace with no air in excess of the amount theoretically required is an ideal condition. The approach to this ideal is measured by the amount of unburned combustible carried to the ashpit and flue, and by the amount of excess air and combustible gases found in the flue gas. There are seven principal constituents usually found in flue gas, namely, carbon dioxide, oxygen, carbon monoxide, nitrogen, methane, and sulphur dioxide and trioxide. Usually these seven main constituents give a sufficiently accurate indication of furnace conditions. The carbon dioxide content alone gives a rough approximation of these conditions.

When the present revision of the A.S.M.E. Power Test Codes was begun in December, 1918, it was decided to shorten the text of the twenty-three test codes of prime movers and auxiliary apparatus by placing in a separate group of publications the supplementary data and information which is of general interest to the users of more than one test code. This group of publications was given the name of "Instruments and Apparatus," since the material which they contain deals primarily with the description of approved instruments and apparatus, together with methods of measurement.

Copies of these preliminary drafts of this Test Code and the sections of "Instruments and Apparatus" are available to those specially interested, and may be obtained on application to the headquarters of the Society. The Committee and the Society will welcome suggestions for corrections and additions to this report. They should be addressed to the Chairman, Committee on Power Test Codes, care of The American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y.

CORRESPONDENCE

Contributions to the Correspondence Department of "Mechanical Engineering" are solicited. Contributions particularly welcomed at all times are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on its activities or policies in Research and Standardization.

Engineers and Economics

To the Editor:

The interest which engineers are taking in economics is very encouraging. Engineers have a considerable advantage over other professions in trying to get at the root of things, for they not only are trained to reason carefully but they are used to having their hypotheses discussed frankly, and neither hesitate to show where the reasoning of another is based on false assumptions, nor to accept corrections which are offered for no other reason than to make it possible to arrive at a true formula for the basic facts so that there will be a firm foundation of truth back of any conclusion which may be arrived at.

Is it amiss to indicate some of the pitfalls which may be encountered in dealing with economic problems?

We are all amateurs in the science of economics. Many of today's problems are old and have been fully studied in the past, and in some cases tried and found wanting. For example, Mr. Lincoln's suggestion as offered in his letter in the September issue of Mechanical Engineering is essentially the "Single Tax" which was agitated some forty years ago. Volumes were written on it and it was given trials in one of the Western cities of this country and in some of the British colonies. Those who are interested can find abundant reading matter by taking the list of books given under the articles on Henry George in the encyclopedias. Or again Mr. Kittredge's suggestion in the August issue will be found to be essentially along the lines of the campaign which the American Federation of Labor waged a generation ago to have consumers buy only goods bearing the union label.

The discussion as to the responsibility of engineers for the present state of affairs has taken an unfortunate turn. That our work is as important as any other one factor is true—but there are so many other factors. For us to seriously debate whether we are principally responsible might leave us open to some very humorous criticism.

In debating economic questions it is dangerous to try to prove one's arguments by a paragraph lifted from some article. If the writer of that article gave proofs, use the proofs; if he gave no proofs, be suspicious of the conclusions. Maybe he expressed a mere wish and not a fact.

Don't generalize from a few isolated incidents. Each industry has its peculiarities, but the average for the country as a whole may be quite different.

Don't try to treat the whole economic system and its remedies in a few paragraphs. H. G. Wells used two large volumes for his "Work, Wealth, and Happiness of Mankind," and says he had to leave out much that could have been properly included. By the way, Wells's book is written in a way that particularly appeals to a technically trained man.

In the past, industry has been considered as consisting of the farm, the factory, and the mine. These have greatly lowered their relative part of the whole—they total perhaps less than a third of the work of the community—if "factory" is limited to mass production and farming to those that make a business of it; i.e., excluding those that just "live on the soil," the total may be less than a quarter. There has been too much waste effort as the result of going on the assumption that solving the problems of industry in its old restricted sense and the factory in particular is all that is necessary to bring back prosperity to the country.

We have a very considerable fraction of our potential workers unemployed. Estimates vary greatly, and even the highest scarcely seem to include women in the home who would like to work and young people who are keeping in school because there is no work to be had. The real problem of ending the

depression is to find something for these people to do. Any suggested solution which does not start with that as a basis is in the nature of the school of medicine which follows the principle that "if the patient can be kept alive long enough, nature will effect a cure"—often a very good procedure—but the present case seems to indicate that an antitoxin needs to be administered.

Do not confuse cause with effect—a mistake made all too often, and one which is particularly annoying to an engineer.

When an engineer completes a calculation he estimates the "probable error." Do the same with economic reasoning.

Watch out for the meaning of words. Textbooks on economics go to considerable length to define the terms which will be used in them—but all authorities do not follow the same nomenclature, and popular writers are extremely hard to interpret. A very prevalent difficulty is that of confusing "Credit" with "Wealth."

We are in a world-wide depression. A suggested cure can be of small importance if it applies only to a local condition.

The causes of the depression are deep-seated. My own opinion, for what it may be worth, is that the war was a result and not a primary cause, although it has had tremendous effects in first stimulating and then retarding the normal flow of commodities.

Many proposed remedies are beyond the possibility of being carried out in a country governed as ours is. The Federal Government is limited by the Constitution, and individual states dare not make radical experiments.

Human nature must be considered. Mr. Shepard in his article "Planning for Prosperity" in the August issue brings this out strongly. It should be brought out strongly.

The list of "don'ts" given is scarcely complete. It is offered merely as a partial guide in the hope that it will make it possible to more quickly bring out useful discussion.

To my mind it is going to take a long time to put into practice a solution of the problem. It is the more difficult because the press and people in public life hesitate to frankly state some of the hard underlying facts. Engineers can use extreme frankness in their report without fearing the consequences. If the engineers of the country can arrive at a consensus of opinion as to what should and can be done, they will do a service not only to the country but to themselves.

The Report of the American Engineering Council's Committee on the Relation of Consumption, Production, and Distribution is a fine beginning. If all who are interested in the work will get back of it and be given the hearty support of the profession, a real work will have been done.

R. E. KINSMAN.[1]

Elmira, N. Y.

The Economic Aspects of Stabilization

TO THE EDITOR:

I have read Mr. Jordan's address which appeared in the January issue of MECHANICAL ENGINEERING and have particularly noted a paragraph on page 29 as follows (the italicizing is mine):

> We can, if we wish, quite simply and easily prevent oversaving, overinvestment, overexpansion of productive capacity, without waiting for this purchasing power to be confiscated by competition, inflation, and deflation in the cycle of boom and depression by taxing away with suitable income surtax rates and inheritance taxes *all* excess corporate savings and *surplus* individual income that cannot be spent by the recipients on *consumers' goods* or replacement of obsolescent equipment, and spending this surplus through governmental channels for the production of free social income by building public works, parks, museums, recreation centers, roads—all of which do not offer commodities or services for competitive sale, and in the building of which purchasing power for other goods is released in wages.

[1] Mem. A.S.M.E.

I am not an economist and am therefore not competent to discuss economic questions with authority, but as a reader of your publication and a member of the Society, I feel moved to protest against the publication of such nonsense in MECHANICAL ENGINEERING and to remark that this proposal in my opinion is an outrage against common-sense.

The objections to this proposal are so many and so obvious that it does not seem worth while to mention them in detail; but among others, who is going to decide what consumers' goods I shall purchase for myself and family, and, the decision having been made, who is going to be bold enough to enforce it? And what is to become of my savings for insurance, doctors' bills, and family security?

Security would vanish except in the Russian sense that every one would be perfectly secure in his misery and each individual would become an apathetic, persecuted cog in a vast and vicious bureaucracy. It seems obvious that such a régime would thus destroy the capitalistic system as we now know it just as thoroughly as it has been destroyed in Russia.

This is the sort of statement I should expect to read in some vehicle of Bolshevik propaganda, but I must say I am surprised to find it in a publication of the high class and conservative nature of MECHANICAL ENGINEERING.

ROBT. D. PIKE.[2]

Emeryville, Calif.

Comments on August "Mechanical Engineering"

TO THE EDITOR:

I have been reading with interest the various articles in MECHANICAL ENGINEERING touching on the present economic situation and in particular the letters by A. E. Kittredge on "A Plan to Promote Economic Stability," and by S. D. Mitereff on "The Balancing of Economic Forces" that appeared in the August issue.

I doubt if there is any one who has given this problem any thought who does not agree that there is too wide a gap between production and consumption, and very few, I believe, would concede that in any way should we discard modern machinery to help the situation.

The main trouble is not that we have advanced too far with modern machinery for the good of the general public, but that society has not kept pace with the advancement of modern machinery. Certainly our ancestors who worked 12 to 14 hours a day were no better off than we are today under present conditions and I heartily agree with the writers of these letters that the reduction of wages is a very poor way to bring back prosperity. Surely, society should benefit by the advancement of mechanical science. By maintaining a higher standard of wages, the buying power of the public would be maintained and the reduction of hours through the development of modern machinery would naturally afford the public more leisure and an opportunity to enjoy more of the pleasures of life.

I believe that we all agree with these conditions, but it is difficult to bring about the change. In the past the benefits derived from more modern machinery have not been passed on to the

[2] Vice-President and General Manager, California Corporation. Mem. A.S.M.E.

general public to the extent that they should have been.

In this same issue appears also a third letter by J. E. Bullard entitled "Danger of Government Ownership." I should like to express my personal gratification for its publication, as certainly one of the biggest calamities that could happen to this country would be complete government ownership.

Z. E. Colby.

Saginaw, Mich.

A Classification Scheme

To the Editor:

I submit for the consideration of your readers a classification of natural phenomena based on the relation between potential and work, which I do not recall having seen stated before.

1 *Work proportional to minus first power of potential.*
Gravitational attraction and electromagnetic attraction.

Force = Kmm'/d^2
Work = Kmm'/d

2 *Work proportional to first power of potential.*
(*a*) Motion of particles in powerful field, such as falling bodies close to the earth
(*b*) Also expansion of gases by heat (external work).

Force: (*a*) $F = Mg$ (*b*) $F = PA$
Work: $W = Mgh$ $W = PV = RT$

3 *Work proportional to second power of potential.*
Electric currents obeying Ohm's law.

Work, $W = I^2R = E^2/R$

4 *Work proportional to third power of potential.*
Not yet identified.

5 *Work proportional to fourth power of potential.*
Heat radiation from black body obeying Stefan-Boltzmann law.

Work, $Q = \sigma T^4 At$

Whatever other forces may be discovered, their nature may be indicated by this grouping. For instance, biological and economic forces, in certain cases, can be so grouped and on this basis proved to be mixed.

Wm. F. Turnbull.[3]

New York, N. Y.

Hydroelectric Development in Canada

To the Editor:

In his article on "Hydroelectric Development in Canada," in the August issue of Mechanical Engineering, the author, Mr. T. H. Hogg, states that the position of the Kaplan turbine is not definitely established in Canada, as it has so far been used only for small installations where high kilowatt-hour output under very variable heads and water conditions is essential. He also states that, when desirable, one or two Kaplan units may be used to improve the efficiency of a plant having several fixed-blade-propeller units. In principle the author is correct, and in many smaller plants this is being done. It should be pointed out, however, that in many large plants there has been a tendency to install Kaplan turbines exclusively, since in many cases a high degree of flexibility is desired. In one important installation this has been because of ownership in the plant by several financial interests, and the desirability of delivering the output of the plant in several directions. Any inability to operate all units in parallel would greatly restrict the utilization of a few Kaplan units for improving overall efficiency.

Further considerations must be taken into account which lead to justification for selection of all-Kaplan units. In the first place, although for small sizes there is a considerable price difference between Kaplan and fixed-blade-propeller machines, for large sizes this price difference becomes a comparatively small percentage of the cost of the turbines alone, and therefore an almost negligible percentage of the total cost of the project when dam, water rights, etc., must be considered. There is an advantage in complete interchangeability among all units, but perhaps of prime importance in run-of-river plants is the fact that they suffer little reduction in output when the head is cut down by high tailwater. The Kaplan unit possesses an important advantage in securing large output in given space requirements, particularly for low heads, and makes possible the development of sites which would not be economical with other types of wheels.

Carroll F. Merriam.[4]

Baltimore, Md.

A 732-Mile Pipe Line

To the Editor:

On page 225 of the March issue of Mechanical Engineering I note a mistake in my letter, both as it was written to you and as it was transcribed. The second sentence of the second paragraph should read:

"This coating, burning in the arc less rapidly than the electrode melts, forms in effect a crucible around the arc, protecting it for almost its entire length. As the coating burns it gives off the *non-oxidizing* gas which prevents oxygen and nitrogen in the ambient atmosphere from reacting with the molten metal."

It will be noted that "non-oxidizing" should be substituted for "oxidizing."

A. F. Davis.[5]

Cleveland, Ohio.

Eight or Sixteen?

To the Editor:

The letter of E. M. Tingley on page 662 of the September issue interests me. Not because I think there is any possibility of its adoption, but because it recalls the plan proposed by John W. Nystrom, of Philadelphia, author of "Nystrom's Handbook," well over 50 years ago. Nystrom's plan was to use 16 as a base and was, as I recall, advanced in opposition to a proposal to use 12 as a base, in what was called the duodecimal system.

I believe that Mr. Tingley will be interested in studying the proposal made by Mr. Nystrom so long ago. He can probably find full details in The Franklin Institute, in Philadelphia. But although I see no advantages in the metric system, I feel sure we shall continue to use decimals for fine measurements. And I doubt if even two generations see the adoption of or any decided movement toward a system radically different from the one we now use. If any change is made, I doubt its being toward either 8 or 16 as a base.

Fred H. Colvin.[6]

New York, N. Y.

[3] Equipment Engineer, Third Ave. Railway System. Mem. A.S.M.E.

[4] With Pennsylvania Water & Power Company, Baltimore, Md. Mem. A.S.M.E.

[5] Vice-President, The Lincoln Electric Company.

[6] Editor, *American Machinist*. Mem. A.S.M.E.

BOOK REVIEWS AND LIBRARY NOTES

THE Library is a cooperative activity of the A.S.C.E., the A.I.M.E., the A.S.M.E., and the A.I.E.E. It is administered by the United Engineering Trustees, Inc., as a public reference library of engineering and the allied sciences. It contains 150,000 volumes and pamphlets, and receives currently most of the important periodicals in its field. It is housed in the Engineering Societies Building, 29 West 39th St., New York, N. Y. In order to place its resources at the disposal of those unable to visit it in person, the Library is prepared to furnish lists of references on engineering subjects, copies of translations of articles, and similar assistance. Charges sufficient to cover the cost of this work are made.

The Library maintains a collection of modern technical books which may be rented by members residing in North America. A rental of five cents a day, plus transportation, is charged. In asking for information, letters should be made as definite as possible, so that the investigator may understand clearly what is desired.

Fundamentals of Instrumentation

Fundamentals of Instrumentation. Part I of the Manual of Instrumentation, by M. F. Béhar. Instruments Publishing Company, Pittsburgh, 1932. Cloth, 6 × 9¼ in., 109 pp., 50 figs., $2.

Reviewed by H. Diederichs[1]

THIS little volume is an auspicious beginning of a very extensive undertaking to cover the entire field of instrumentation as applied to the science of engineering.

The entire work is to consist of the following parts:

1 Fundamentals of instrumentation
2 Temperature measurement and control
3 Humidity measurement and control
4 Pressure measurement and control
5 Time and speed measurement and control
6 Flow measurement and control
7 Electricity
8 Miscellaneous measurements.

Up to the present only Part I has appeared in book form. Some of the other parts have appeared as serials in *Instruments*, while some are yet in preparation. Only Part I, which contains a general discussion of matters common to all subdivisions of the instrumentation field, is covered by the present review.

The underlying purpose of the series of publications is concisely stated in a quotation from Pascal that "to measure is to economize," and the actual process by which that dictum is realized is best shown by reproducing what Béhar has to say about the role of instruments in present-day industrial life. To quote:

"A new process is discovered. There are commercial possibilities. Production is begun on a small scale. Conditions, such as temperature, pressure, etc., are studied; that is to say, they are measured by means of instruments. Measuring instruments are purchased. Next, in order to know not only what the condition, such as temperature, *is*, but what it *was* over a period of time, recording instruments are installed. Through study of all data collected, improvements are made in the process, in the primary equipment, and in the instruments. The engineer in charge now determines the exact value, point, or degree for the one best condition—such as, say, temperature. He orders an automatic temperature controller. This, however, is not the final stage. The elimination of the human element from temperature control impels the manufacturer of the primary equipment to improve it further; and with both better primary equipment and secondary equipment at his disposal, the production engineer is encouraged to improve the process itself. It always is an endless cycle."

No words of the reviewer can improve upon this picture, and nothing brings out more clearly the difference between this series of publications on instruments and those that have preceded it. The writer of this review is himself co-author of one of these previous publications. He has been severely criticized by certain authorities on instruments for leaving out all discussion of *control* instruments and apparatus. This was done deliberately after mature consideration on the ground that control instruments are not *testing* instruments and should therefore have no place in college texts dealing with testing instruments, their construction, use, and application, which, with the possible exception of the forthcoming A.S.M.E. Code on Instruments, is practically the only field covered by previous publications. The decision to leave out of such texts the discussion on control instruments may have been wise or unwise. However that may be, the charge of being incomplete in this respect can never be lodged against the series of publications projected here, and the practicing engineer will find in every case the complete treatment of the theory, construction, and use of a wide variety of instruments, together with a discussion of the application of such instruments, or modifications of them, as control instruments. And this is important, for in the operating field today, control instruments are of greater consequence than testing instruments.

So much for the general purpose of the publications. The present small volume deals in the first chapter with industrial instruments in general, their classification by objects of measurement or control, their classification by functions, and the chapter ends with a general discussion of the principal parts of industrial elements and of the essential parts of controllers. It is well known to any one who has attempted it how difficult it is to give a precise classification of instruments and their essential parts upon any logical basis, and Béhar's attempt is certainly the most ambitious and probably the most successful made in that line.

The second chapter deals with the properties and characteristics of industrial measuring instruments, and defines and discusses the relation between accuracy and error and the measurement of these properties, the meaning of precision, sensitivity, variance, lag, sluggishness, drift, and set. It is a competent discussion on these matters and covers some twenty-four pages, the most extensive to the writer's knowledge, except perhaps some of the writings by Schlinck and

[1] Professor and Head of the Department of Experimental Engineering, Cornell University, Ithaca, N. Y. Mem. A.S.M.E.

other experts of the Bureau of Standards on some of the special topics mentioned. It should be read by every engineer who has any extended dealings with measuring instruments if he is to have a thorough understanding of the limits of accuracy and precision that he may expect from his instruments. The treatment is refreshing, being distinctly off the beaten path of the dry discussion with which the subject-matter of this chapter is generally presented.

The third chapter deals with the performance of automatic controllers, and here breaks new ground. Béhar shows that in practically all automatic controllers, time is the important thing, and that it is possible to split up the sum of the time factors in any system of control into two groups—those inherent in the controller and those belonging to the controlled apparatus. The former group of time factors, since they are conditioned by design, is predictable in its effects; the second group, since it varies with every application, is not. Béhar summarizes the first group under the general collective name of "controller period," the second under the general designation of "application lag," and proceeds to give a detailed discussion of each, and their interrelation, with illustrations. This is followed by definitions and discussions of the terms *demand*, *capacity*, the *control valve*, meaning by this, in general, any device which forms the final element in any control system, the *power device*, *extent of corrective action*, and finally what Béhar chooses to call *modes of control*, in reality types, systems, and manners of control. Again the treatment of all these matters is quite original, not the least ingenious device being the method used to illustrate some twenty classes of modes of control. Here Béhar asks the reader, presumably an engineer, to place himself between the measuring device on the one hand and the control device on the other, acting thus as the controller, and he proceeds to analyze the mental and physical reactions of the human controller as function of the demand. This method is thoroughly effective in fixing the possible systems and their efficacy in the reader's mind. The chapter ends with a brief discussion upon the selection of a controller, based upon the discussion that has gone before. It is pointed out that, particularly in a new application, a systematic study of the problem is a prime necessity, but that in most cases today the prospective user should be able to find trained representatives of instrument companies disinterested enough to be of real service in selecting the proper equipment or designing new apparatus.

The fourth and last chapter of the book is a collection of seven articles written by different individuals, some for the book, others for other publications, and reprinted here. These articles deal largely with the personnel, location, function, and operation of an instrument department in an industrial plant. The recommendations of the writers are in general the same, except for details. They all agree, as any engineers must who have thought about the matter, that the instrument department should have complete supervision over the industrial control elements in a plant, and with very few exceptions, should permit no interference by any other department in the plant with its functions. This department should have the care of the installation, repair, replacement, and daily servicing of all control instruments, and should have a stock of exchange instruments to loan to various departments of the plant as they may be called for. The general conclusion is that any other system of supervision over instruments, particularly divided responsibility, would lead to chaos in short order and make the plant revert to manual control. To all of which the writer of this review can heartily subscribe.

The book closes with an extended bibliography, but contains no index.

Mechanical Fabrics

MECHANICAL FABRICS. By George B. Haven. John Wiley & Sons, Inc., New York, 1932. Cloth, 6 × 9 in., 905 pp., illus., diagrams, charts, tables, $10.

REVIEWED BY EDWIN H. MARBLE[2]

IN THE volume here under consideration, Professor Haven first deals with some of the more prominent mechanical fabrics whose characteristics the engineer must know to determine if they will meet the specific requirements of the work for which they are to be used. These include tire, balloon, and airplane fabrics. The methods of testing these various structures, the apparatus best suited, and the method of procedure are all clearly described.

A standard condition is given, and the tests for determining if there is any deviation from that condition and the correction of such deviation are carefully outlined.

The engineer will be interested in the sections dealing with the equipment of a testing laboratory, the apparatus for determining strength, stretch, and moisture content and its influence on strength, for he may wish to determine the porosity of a fabric, the amount of heat transmission through a fabric, the adhesion during a vulcanizing process, each a requirement that if not determined and met would have an influence upon the finished product.

As a reference book the reviewer finds it most valuable in that it tabulates the Standard Specifications of the American Society for Testing Materials, and also the Government Specifications of Mechanical Fabrics.

The author emphasizes the value of the microscope to the engineer not alone for the identification of the various fabrics, but for the selection of a fiber which, when manufactured into a suitable fabric structure, will best meet the requirements called for.

A brief outline of some essential requirements of a standard mill organization concludes the book.

The volume summarizes the research work carried on for many years under the supervision of the author, and with the increased call for mechanical fabrics, should be in the library of every engineer. It is a valuable addition to our fund of research literature.

Books Received in the Library

AVIATION AND THE AERODROME. By H. A. Lewis-Dale. J. B. Lippincott Co., Philadelphia, 1932. Cloth, 6 × 9 in., 168 pp., illus., diagrams, charts, tables, $6. This book deals with the question of sites and the broad aspects of the engineering problems of a more or less specialized character which are involved in the construction and ground equipment of aerodromes. These problems are treated concisely and definitely, and numerous examples of plans and buildings are included. The author has been engaged since 1914 in the construction of aerodromes for the British Admiralty and Air Ministry.

DIE FERROMAGNETISCHEN LEGIERUNGEN. By W. S. Messkin and A. Kussmann. J. Springer, Berlin, 1932. Cloth, 6 × 10 in., 418 pp., illus., diagrams, charts, tables, 44.50 r.m. The aim of this book is to systematically survey the ferromagnetic metals and alloys, and to present in a practical way not only their properties from a magnetic point of view, but also the influence of metallurgical treatment upon these properties. The work is therefore designed to serve the metallurgist, the physicist, or chemist engaged in research work, and the electrical engineer. The theory of magnetism opens the work, after which the author discusses magnetic measurements, the influence of chemical composition and physical state upon magnetic properties, magnetic analysis of metals, physical properties, permanent-magnet steels, alloys for dynamos, transformers, etc., and the production of magnetic alloys. The author has endeavored to consider all the alloys now used industrially and those that offer prospect of such use.

[2] President, Curtis & Marble Machine Co., Worcester, Mass. Mem. A.S.M.E.

A.S.M.E. ANNUAL MEETING

New York, December 5 to 9, 1932

MORE than ever, perhaps, is assurance welcome that science and technology and the activities of engineering societies have made steady progress, and that the interests of engineers in the closely related field of economics have broadened and strengthened. The program of the Annual Meeting of The American Society of Mechanical Engineers printed on these pages is evidence of this assurance. For the five days in December given over to this meeting, December 5 to 9, mechanical engineers who are able to attend will be provided with an abundance of subjects to ponder over and discuss, and the usual opportunities for renewing old friendships and forming new ones.

One significant trend in programs of A.S.M.E. Annual Meetings, strikingly displayed this year, is the interest shown in papers of the more theoretical, although thoroughly practical, type. For example, the Applied Mechanics Division's symposium on Working Stresses, which is spread over three sessions and includes ten papers in addition to a progress report, deals in a thoroughly scientific manner with three groups of subjects that are of the greatest practical importance to engineers and particularly designers—theories of strength and fatigue, high-temperature effects, and impact effects. The symposium is international in character from the point of view that two of the papers originated in Europe—one by a German and the other by a Russian.

Contemporary economic problems are given an important place on this year's program, as indeed they were on last year's, once more bearing out the belief held by engineers that their interests and their technology cannot be detached from present-day influences in the world of business affairs and those of economic and fiscal policies. The Management Division of the A.S.M.E has shown commendable enterprise in providing papers for the discussion of such important subjects as the distribution of surpluses, long-time planning, trade associations, decentralization of plants, analysis of business characteristics, and management essentials for recovery, and a forum in which engineers may listen and learn, as well as express their own views.

Technological advances form, of course, the bulk of the program, as usual. The custom of presenting reports of progress for the year will be followed by the Professional Divisions, augmenting the numerous technical papers by eminent authorities on topics of special and timely interest.

Opportunity is also afforded numerous A.S.M.E. and joint committees to meet, report progress, and plan for further work.

Critical days, in the immediate past and yet to come, make especially important this year sober attention to non-technical phases of engineering, and particularly those that concern the A.S.M.E. as an organization of professional men. Meetings of the Council, of the delegates from the Society's Local Sections, and the business meeting of the Society, as well as numerous luncheons, dinners, and impromptu gatherings, formal and otherwise, provide the means by which problems affecting the individual engineer and the Society can be discussed.

And finally there are matters relating to the social amenities that add color, good-fellowship, and dignity, and give vitality and individuality to the moving and changing group that meets every year as an engineering society.

An outline of the Program of the 1932 Annual Meeting of The American Society of Mechanical Engineers follows. Members wishing preprints of papers are requested to order them by number, using the blank on page 810.

MONDAY, DECEMBER 5

9:00 a.m. Conference of Local Sections' Delegates

9:30 a.m. Council Meeting
Simultaneous Sessions:

Applied Mechanics (I)

Theories of Strength, A. Nadai [30]
Working Stresses for Columns and Thin-Walled Structures, S. Timoshenko [47]
Stress-Concentration Phenomena in Fatigue of Metals, R. E. Peterson [33]
Fatigue of Metals—Its Nature and Significance, H. F. Moore [27]

Railroad (I)

Horsepower and Tractive Effort of Steam Locomotives (Locomotive Ratios), A. I. Lipetz [22]
Progress Report of Railroad Division

Iron and Steel and Fuels (I)

Use of Blast-Furnace Gas in Soaking Pits, G. T. Hollett [18]
The Effect of Reradiation Upon the Transmission of Radiant Heat From Furnace Walls and Openings, J. D. Keller and H. C. Hottel [19]

12:15 p.m. Luncheon, Council and Local Sections' Delegates

2:00 p.m. Business Meeting

2:00 p.m. Conference of Local Sections' Delegates
Council Meeting

2:30 p.m. Simultaneous Sessions:

Applied Mechanics (II)

Application of Creep Tests, G. H. MacCullough [23]
Factors Affecting Choice of Working Stresses for High-Temperature Service, P. G. McVetty [25]
Metals at High Temperature—Test Procedure and Analysis of Test Data, Ernest L. Robinson [39]

Iron and Steel (II)

The Rolling and Extrusion of Aluminum and Its Alloys, R. L. Streeter [44]
Carburizing With Butane Gas, C. W. Spicer [43]
Progress Report of Iron and Steel Division

Railroad (II)

Car Construction of the Future, C. E. Barba [3]

Power-Test Public Hearing

Public Hearing on Test Code for Centrifugal Compressors, Exhausters, and Fans
Pulsation in Air Flow From Fans and Its Effect on Test Procedure, H. F. Hagen [15]
Influence of Bends in Inlet Ducts on the Performance of Induced-Draft Fans, L. S. Marks, J. Lomax, and R. Ashton [24]

6:15 p.m. Informal Dinner, Executive Officers and Representatives of Professional Divisions

8:00 p.m. Program for evening to be announced later

TUESDAY, DECEMBER 6

8:50 a.m. Lecture on "Talking With an Audience," Dr. S. Marion Tucker

9:00 a.m. Conference, Local Sections' Delegates

9:30 a.m. Simultaneous Sessions:

Applied Mechanics (III)

Concerning Notched-Bar Tests, Max Moser (Translated by A. van Kiekerk) [28]
Allowable Working Stresses Under Impact, N. N. Davidenkoff [11]
Suggestions on Choice of Working Stresses, C. R. Soderberg [41]
Progress Report of Applied Mechanics Division

Machine-Shop Practice (I)

(Jointly With Cutting of Metals Research Committee)

Progress Report No. 4, Cutting of Metals Committee, O. W. Boston and C. J. Oxford [5]
Effect of Lathe Cutting Conditions on the Hardness of Carbon and Alloy Steels, T. G. Digges [13]

Materials Handling

Materials Handling as a Factor in the Transportation of Commodities, M. W. Potts and J. A. Cronin [37]
Effects of Modern Transportation Requirements on the Evolution of Railroad Equipment, C. B. Peck [32]
Progress Report of Materials Handling Division

Industrial Power

Observation of Liquid Water in Steam Passages and Means for Effecting Separation, C. C. Thomas [45]
High-Pressure Steam-Generator Research, A. A. Potter, H. L. Solberg, G. A. Hawkins, and P. A. Willis [36]
Progress Report of Power Division

2:00 p.m. Simultaneous Sessions:

Machine-Shop Practice (II)

(Jointly With Cutting of Metals Research Committee)

What Can Be Accomplished With Modern Machine Tools and Cemented-Carbide Cutting Tools, A. A. Merry [26]
Grinding Cemented-Tungsten and Tantalum Carbide Tipped Tools Efficiently and Economically, J. M. Highducheck [16]

Mechanical Springs

Number of Active Coils in Helical Springs, R. F. Vogt [52]
Progress Reports of the Mechanical Springs Research Committee

Iron and Steel (III)

(Jointly With Anti-Friction Bearings Research Committee)

The Morgoil Roll-Neck Bearing, F. P. Dahlstrom [10]
Strength of Roll Necks, W. Trinks and J. H. Hitchcock [50]

Fuels

The Measurement of Metal Temperatures on the Heat-Receiving Side of Heat-Exchanging Apparatus, Arthur Williams [53]
Stoker Development at Delray Power House No. 3, The Detroit Edison Company, Paul Thompson and Fred S. Chatel [46]
Progress Report of Fuels Division

4:30 p.m. Henry Robinson Towne Lecture

8:30 p.m. Presidents' Night and Conferring of Honors

WEDNESDAY, DECEMBER 7

8:50 a.m. Lecture on "Talking With an Audience," Dr. S. Marion Tucker

9:30 a.m. Simultaneous Sessions:

Machine-Shop Practice (III)

Special Steel for Castings, R. A. Bull [6]
Malleable Iron as a Component Part of Machines and Structures, E. Touceda [48]
Progress Report of Machine Shop Practice Division

Management (I)

Surpluses—Their Distribution
Long-Time Planning—For Individual Concerns
Trade Associations—Their Services

Hydraulic (I)

Problems of Modern Pump and Turbine Design, Wilhelm Spannhake [42]
Research Institute for Hydraulic Engineering and Water Power, Hunter Rouse (Trans. A.S.M.E., HYD-54-3, May 15, 1932)

Textile

Peroxide Bleaching of Textiles, an Outline of Its Recent History, Present Applications, and Immediate Prospects, H. G. Smolens [40]
Elements of Cost in Dyeing Cotton Piece Goods, J. Andrew Clark [7]
Progress Report of Textile Division

12:15 p.m. Luncheon, Council and Student Branches

2:00 p.m. Conference, Student Branch Delegates
Simultaneous Sessions:

Management (II)

The Economic Characteristics of the Manufacturing Industries, W. Rautenstrauch [Published in this issue]
The Dissolving of Concentrated Industries, Harold V. Coes [8]
Management Essentials for Recovery, Carle M. Bigelow [Published in this issue]

Oil and Gas Power

Application of Diesel in the Small-Boat Field, A. B. Newell [31]
Progress Report of Oil and Gas Power Division

Steam Tables

Progress Reports of Thermal Properties of Steam Research Committee

Hydraulics (II)

A Study of the Data on the Flow of Fluids in Pipes, Emory Kemler [20]
Progress Report of Hydraulic Division

6:30 p.m. Annual Dinner, Hotel Astor

THURSDAY, DECEMBER 8

8:50 a.m. Lecture on "Talking With an Audience," DR. S. MARION TUCKER

9:30 a.m. Simultaneous Sessions:

Aeronautics

Modern Airfoil Theory, ALBERT TOUSSAINT (Translated by ALEXANDER KLEMIN) [49]
Meteorology in Relation to North Atlantic Flight, JAS. H. KIMBALL [21]
Progress Report of Aeronautic Division

Management (III)

Ten Years' Progress in Management, L. P. ALFORD [1]
Applications of the Kmh Method of Analyzing Manufacturing Operations, L. P. ALFORD and J. E. HANNUM [2]
Progress Report of Management Division

Central-Station Power

Stresses in Boiler Tubes Subject to High Rates of Heat Absorption, WM. L. DEBAUFRE [12]
A System for Measurement of Steam With Flow Nozzles for Turbine Performance Tests, SANFORD A. MOSS and WISTAR W. JOHNSON [29]
Performance of Modern Steam-Generating Units, C. F. HIRSHFELD and G. U. MORAN [17]

12:30 p.m. Luncheon, Honorary Chairmen of Student Branches

2:00 p.m. Simultaneous Sessions:

Education and Training for the Industries

The Engineer's Interest in Foreman Training, EDWARD S. COWDRICK [9]
Fundamentals of Training, G. GUY VIA [51]
Adult Technical Education, OVID W. ESHBACH [14]

Petroleum

Some Problems on the Lubrication of Vertical Journal Bearings, A. I. PONOMAREFF and E. D. HOWE [35]
Chemistry of Lubrication, W. F. PARISH and LEON CAMMEN
Progress Report of Petroleum Division

4:30 p.m. Robert Henry Thurston Lecture

8:00 p.m. **Printing Industries Session**

General Demonstrations

College Reunions

FRIDAY, DECEMBER 9

9:30 a.m. Council Meeting

FORM FOR ORDERING ADVANCE COPIES OF 1932 A.S.M.E. ANNUAL MEETING PAPERS

NOTE: The Papers listed by number in the program on pages 808–810, to be presented at the A.S.M.E. Annual Meeting, December 5 to 9, 1932, will be available about November 15 in pamphlet form and may be secured without cost by any member of the Society.

Check numbers in request below and mail to Secretary, A.S.M.E., 29 West 39th St., New York, N. Y.

Order Number		Reserved for Date Stamp
Written		
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AIR COMPRESSORS

GAS- AND OIL-ENGINE-DRIVEN. Vis-a-vis Gas and Oil Engine-Driven Air Compressors. Engineer v 154 n 3997 Aug 19 1932 p 181–2. Gas and oil engines directly coupled to single-acting horizontal two-stage compressor at Sandiacre works of Premier Gas Engine Co.; compressor sets have undergone extended series of efficiency and fuel consumption tests; gas engine and valve gear; governor and oil-pump arrangement.

AIRPLANE ENGINES

COOLING. Heat Dissipation From Finned Cylinder at Different Fin-Plane/Air-Stream Angles, O. W. Schey and A. E. Biermann. Nat Advisory Committee Aeronautics—Tech Notes n 429 Aug 1932 11 p 12 supp plates. Experimental determination of temperature distribution in and heat dissipation from cylindrical finned surface; with air speed of 76 mph, heat input to cylinder can be increased 50 per cent at 45-deg fin-plane air-stream angle over that at 0°.

PACKARD. Adaptation of Diesel Engines to Aircraft, H. C. Edwards. Diesel Power v 10 n 7 July 1932 p 300–3. Design and operating advantages of Diesel aircraft engine; adoption of Diesel engine for aircraft propulsion probably will become almost necessity when used in commercial transport service; illustrated description of design details of 9-cyl Packard-diesel aircraft engine; fuel-pump mechanism.

SUPERCHARGING. Comparative Performance of Powerplus Vane-Type Supercharger and N.A.C.A. Roots-Type Supercharger, O. W. Schey and H. H. Ellerbrock, Jr. Nat Advisory Committee Aeronautics—Tech Notes n 426 July 1932 14 p 10 supp sheets. At pressure differences from 10 to 14 in. of mercury and at speeds over 2000 rpm, power requirements are practically same; because Powerplus supercharger cannot be operated at speed greater than 3000 rpm as compared with 7000 rpm for Roots, its capacity is approximately one-half that of Roots for same bulk.

WRIGHT. Supercharged Conqueror. Aviation Eng v 7 n 2 Aug 1932 p 8–9. Design of Prestone-cooled 12-cyl engine developing 600 hp at 12,000 ft; supercharger driven at 10 times crankshaft speed of engine 2400 rpm.

AIRPLANES

AUTOGIROS. Engineering Aspects of Modern Autogiro, A. E. Larsen. Soc Automotive Engrs J v 30 n 6 June 1932 p 241–53. Fundamental engineering features of development of autogiro by engineering departments of parent American company and its licensees; aerodynamic relationships existing in three or four widely different combinations of rotor and fixed wing.

CLINOGYRE. Le clinogyre Odier-Bessiere. Aerophile v 40 n 7 July 1932 p 209–10. Operating principles of "clinogyre" i.e., monoplane fitted with rotor similar to autogiro but rotating at speed of 400 rpm.

PROPELLERS. Ansaetze zur Berechnung von Verstelluftschrauben, H. B. Heimbold. Zeit fuer Flugtechnik und Motorluftschiffahrt v 23 n 14 July 28 1932 p 413–16. Fundamental formulas for design of controllable-pitch propellers, facilitating procedure of calculations.

SEAPLANES. See *Seaplanes.*

WINGS. Effect of Length of Handley Page Tip Slots on Lateral-Stability Factor, Damping in Roll, F. E. Weick and C. J. Wenzinger. Nat Advisory Committee Aeronautics—Tech Notes n 423 July 1932 6 p 11 supp plates. Tests in N.A.C.A. 7- by 10-ft wind tunnel on Clark Y wing model with slot lengths from 20 to 100 per cent of semi-span; optimum length of slot for satisfactory damping in roll over large range of angles of attack found to be slightly over 50 per cent of semispan.

AIRSHIPS

DIESEL-ELECTRIC. L'emploi de moteurs électriques a courant alternatif polyphasé pour la propulsion des grands avions et áeronefs, R. Jacquot. Revue Générale de l'Électricité v 32 n 3 July 16 1932 p 81–9. Use of polyphase a-c electric motors for propulsion of large airplanes and airships; author studies problem of propellers directly coupled to and driven by squirrel-cage induction motors supplied from engine-driven generator; speed regulation by change of frequency.

ALIGNMENT CHARTS

MULTIVARIABLE. Developed Nomogram, T. H. Blakeley. Engineering v 134 n 3474 Aug 12 1932 p 175–6. By method suggested, expressions containing more variables may be used almost as easily and accurately as three-variable expressions; chart required may conveniently be made of stout cardboard with one slide or two or three slides, depending on number of variables in expression.

ALLOYS

BEARING METALS. See *Bearing Metals.*

BRONZE. See *Bronze.*

HEAT-RESISTING. See *Chromium-Nickel Alloys.*

ALUMINUM

EXTRUSION. Impact Extrusion of Aluminum, H. H. Hall. Am Mach v 76 n 29 Aug 17 1932 p 925–8. Applications of Hooker process in which metal is forced downward through opening in bottom of die; for plain, flat-bottomed cans or shields, process is less costly where length-diameter ratio is greater than one and one half.

AUTOMOBILE ENGINES

BEARINGS. Bearing Manufacturer's Viewpoint on Engine Bearings—I and II, D. E. Anderson. Motive Power v 3 n 5 and 6 May 1932 p 8–10 and 26 and June p 7–9 and 24–7. May: Historical review of internal-combustion-engine bearing developments; bearing characteristics from manufacturer's viewpoint; chart showing method of charting loads and thereby obtaining mean load on connecting-rod bearings. June: Details of different phases of engine operation and vast number of parts that help to shorten or prolong life of bearing. Before Soc. Automotive Engrs.

EFFICIENCY. Variation of Thermal Efficiency With Speed and Torque Determined, P. M. Heldt. Automotive Industries v 67 n 8 Aug 20 1932 p 288–30. Three-dimensional representation of variations with speed and torque of mechanical brake-thermal and thermal efficiency of automotive power plant under normal operating conditions.

TESTING. Electrical Testing Equipment for Motor Car Engines. Engineer v 154 n 3997 Aug 19 1932 p 190. Testing plant installed in Coventry works of Humber-Hillman Motor Car Co.; each consists of 17-kw 460-v d-c machine, designed for speed range of 1000–25,000 rpm and controlled by switchboard with triple-pole ironclad switch and fuse, motor starter with no-volt and overload release devices, and shunt regulator electrically interlocked with starter.

[See also *Motor-Truck Engines.*]

AUTOMOBILES

BRAKE DRUMS. Brake-Drum Metallurgy, F. L. Main. Soc Automotive Engrs J v 31 n 2 Aug 1932 p 330–5 and (discussion) 335–8. Advantages of laminated pearlite structure in steel and cast iron for brake drums; structure secured in pressed steel by alloying or by case hardening; methods of centrifugal casting and of testing; form and microstructure of representative brake drums.

STEERING GEARS. Mechanik der Automobillenkung, H. Lenk. Automobiltechnische Zeit v 35 n 12, 13 and 14 June 25 p 294–9 July 10 p 321–4 and July 25 p 350–4. Kinematic analysis of automobile steering mechanisms; calculation of forces in curves with particular regard to turning over and skidding; derivation of formulas for rating of performance.

TRANSMISSIONS. Daimler Fluid Flywheel. Machy (Lond) v 40 n 1027 and 1028 June 16 1932 p 325–9 and June 23 p 357–61. June 16: Machining operations on components of Fluid flywheel and self-changing gear box. June 23: Gear select- or camshaft; hobbing splines on gear-box drive shaft on Pfauter gear-hobbing machine; tool layout for first, second, and third operations on third-speed gear-box annulus; speeds, feeds, and output of principal machine tools.

AUTOMOTIVE FUELS

COMBUSTION. Verbrennungsverlauf, Luftueberschusszahl, Verpuffungsgrenzen, Abgaszusammensetzung und Heizwerte von Kraftstoff-Luftgemischen, Wawrzinick. Automobiltechnische Zeit v 35 n 9, 10, 12, 13 and 14, May 10

1932 p 236–40, May 25 p 263–6, June 25 p 310–14 July 10 p 335–40, and July 25 p 358–62. Experimental investigation of combustion process, excess air number, combustion limit, exhaust gas composition and calorific value of fuel-air mixture in internal combustion engines. Haber-Loewe interferometer for determining excess air from composition of exhaust gases; determination of hydrogen and methane by fractionated combustion; excess air number, exhaust gas composition, and calorific values for various fuels.

DETONATION. Strobophonometer, R. Stansfield and R. E. H. Carpenter. Instn Petroleum Technologists—J v 18 n 104 June 1932 p 513–25. Method of comparing and locating knock and other engine and machinery noises by means of Carpenter-Stansfield strobophonometer.

BALLISTICS

PRESSURE GAGES. Pressure Measurement in Ballistic Research, C. M. Balfour. Engineering v 134 n 3476 Aug 26 1932 p 231–2. Latest pattern of recording pressure gage used for ballistic investigations has to record development of gas pressure which may reach max of 30 t per sq in. in time as short as 0.004 sec; constructed in Research Department, Woolwich, and design by author for use in larger closed vessels.

BALANCING MACHINES

DYNAMIC. Machines for Dynamic Balancing, C. N. Fletcher. Mech World v 92 n 2379 Aug 5 1932 p 120–1. Use of neon lamp on machine fitted with vibrating bearing supports makes possible balancing of work at very high speeds, and necessity for reversing work and making two readings at each end has been almost entirely eliminated; new machines for balancing rotors and long rolls; machines which measure and control removal of amount of unbalanced material in connecting rods.

BEARING METALS

PROPERTIES. White Metal Bearing Alloys, L. E. Grant. Metals and Alloys v 3 n 6 and 7 June 1932 p 138–45 and 150 and July p 152–8; see also Metallurgist (Supp to Engineer) Aug 26 1932 p 117–9. Survey of principal research on structure and properties of tin-base and lead-base babbitts; physical properties of tin-antimony-copper alloys; pouring temperature and hardness of A.S.T.M. babbitts; effect of impurities on hardness; effect of arsenic on microstructure; solidification intervals of ternary lead-base bearing metals. Bibliography.

BEARINGS

BALL. Ball-Bearing Spindles for Exceptionally High Speeds, R. Allan. Mech World v 92 n 2377 July 22 1932 p 80–2. Bearings for very high speeds must have specially designed ball retainers or be without filling slots; probable life of bearing depends on load conditions and can be determined from suitable life factors; lubrication presents difficulty due to centrifugal effect and overheating due to oil impact; mountings which give satisfactory all-round service.

Wyromatick Compensator Controls Bearing Preloading, A. F. Denham. Automotive Industries v 67 n 9 Aug 27 1932 p 268–9. Use of smaller bearings made possible by new device produced by Federal-Mogul, designed to insure proper adjustment within 0.0025 in.

DESIGN. Criteria for Design of Bearings, L. J. Bradford. Product Eng v 3 n 6 June 1932 p 253–5. Consideration of such factors as bearing pressure, speed of shaft and viscosity of lubricant in design of bearings; concrete example of use of formulas.

LUBRICATION. Some Experiments on Oil Films in Complete Cylindrical Bearings. Stanford Univ Publ—Univ Series (Engineering) v 1 n 1 1932 110 p 4 supp plates. Introduction and Summary, G. H. Marx; Bearing Lubrication. Influence of Surface Velocity on Mean Film Thickness, B. M. Green; Investigation of Mean Thickness of Oil Films in Bearings, E. C. Bennett and W. L. Rifenberick; Oil-Film Thickness in Bearings, R. H. Hartman and W. K. Franklin; Investigation of Journal Positions in Bearing, J. Dentraygues; Oil-Film Pressures and Journal Displacements in Complete Cylindrical Bearings, J. B. Balcomb and R. Mackamey.

BELTS AND BELTING

DATA ON. Quelques indications utiles sur les courroies, M. Varinois. Revue Industrielle v 62 n 2278 Sept 1932 p 442–6. Useful notes on selection of belts; influence of air cushion; horizontal and vertical transmissions compared, elimination of oil; preparation of belts; etc.

BINARY-VAPOR ENGINES

MIXTURES FOR. Zweistoff - Gemenge und Wirkungsgrad der Mischdampfmaschine, H. Mehlig. Archiv fuer Waermewirtschaft v 13 n 8 Aug 1932 p 213–17. Binary mixtures and efficiency of mixed-vapor engines; binary-mixture diagram in three-dimensional graph; calculation of changes in state of mixture; diagram for benzol-water mixture; better performance of mixed-vapor reciprocating engine is attributed to heat-transfer conditions. Bibliography.

BOILER FEEDWATER

TREATMENT. Erfahrungen mit chemisch gereinigtem Speisewasser bei Hochdruckkesseln von 40 atu, F. Koegler. Waerme v 55 n 30, 31 and 32 July 23 1932 p 515–17 July 30 p 529–34 and Aug 6 p 548–53. Experience with chemically treated feedwater in high-pressure boilers of 40 atm; treatment of comparatively impure river water making use of heat content of boiler sludge water; favorable results of long-period tests; scale removal with phosphate-scale prevention by continuous admixture of small amounts of phosphate in feedwater.

L'emploi du phosphate de soude comme détartrant en Allemagne, R. Deullin. Chaleur et Industrie v 13 n 146 June 1932 p 396–402. Various German and American test data, obtained with use of sodium phosphate for boiler feedwater treatment, tabulated and analyzed.

Treatment of Feedwater for High Pressure Boilers, C. E. Joos. Combustion v 4 n 2 Aug 1932 p 19–25. Current review of practice and methods particularly as they apply to high pressure boilers; prevention of deposits; phosphate treatment; embrittlement; low concentration of solids and alkali; internal treatment; zeolite water softeners; evaporators.

BOILERS

CIRCULATORS. Templex Circulator. Engineer v 154 n 3999 Sept 2 1932 p 240. Device made by Lionel Le Sueur and Co. London, designed to cause positive circulation in boiler, consists of specially shaped pipes led up between banks of return tubes for each furnace to point some distance below water surface.

ELECTRIC. Electric Boilers Solve Heating Problems, C. R. Reid. Power v 76 n 3 Sept 1932 p 120–1. General use of electric heaters for hot-water heating system where electric power is purchased at comparatively low rate; characteristics of two specific examples; details of construction of electric water heater.

HIGH - GAS VELOCITY. High Gas - Velocity Boiler. Brown Boveri Rev v 19 n 1 Jan 1932 p 41–51; see also Engineer v 154 n 3998 Aug 26 1932 p 214–15. Development of Brown Boveri Velox boiler with pressure-charged combustion chamber; investigations showed advantages would be obtained if velocities of 200 m/sec and more were used; means is offered by gas turbine using two methods; constant pressure with continuous flame, for crude oil and pulverized coal; and explosion, for explosive combustibles such as gases, various oils, and pulverized lignite.

HIGH-PRESSURE. Die Inbetriebsetzung der neuen Loefflerkessel in Witkowitz, W. Bredtschneider. Archiv fuer Waermewirtschaft v 13 n 8 Aug 1932 p 197–202. New Loeffler boiler in Witkowitz; design and operation of 60 to 75-t per hr pulverized-coal boiler for 130 atm and 500 C; combustion-chamber cooling by radiation superheater; oxyacetylene welding of superheater tubes; steam-circulation pumps; starting of boiler with low-pressure steam.

Les pompes de circulation de vapeur des chaudières à haute pression Loeffler, B. Belohlavek, Génie Civil v 101 n 3 July 16 1932 p 61–4. Design and operating characteristics of piston and of rotary pumps for circulation of steam in Loeffler boilers.

Steam Generation at High Pressures. Power Engr v 27 n 317 Aug 1932 p 293–5. Advantages of new type of high-pressure boiler made by Brown Boveri; diagrammatic arrangement.

VIBRATIONS OF FIRE TUBES. Schwingende Flammrohre, F. Baumgarten. Waerme v 55 n 30 July 23 1932 p 509–14. Vibrating fire tubes; vibration of corrugated tubes up to $2^1/_2$–3 mm at rate of 120 to 200 per min were observed in fire-tube boilers during starting; study of causes; at same time upward deflections of tubes up to 24 mm were measured.

WATER-TUBE. Der Wasserumlauf in Rohrsystemen mit Kurzschlussrohren und in Schraegrohrkesseln, H. Seidel. Zeit des Bayerischen Revisions-Vereins v 36 n 14 and 15 July 31 1932 p 166–70 and Aug 15 p 175–7. Water circulation in tube system with by-pass tubes and in inclined-tube boilers; calculation for determining speed distribution in different tube sections; influence of dimensions on size and speeds; conclusions with respect to water circulation in inclined-tube boilers.

WELDING. Electrically-Welded Boiler Steam Drums. Engineer v 154 n 3998 Aug 26 1932 p 214. Experimental practice at Renfrew works of Babcock and Wilcox; $^3/_4$ in. thick sheet of steel, bent to form cylinder, mounted on new electric fusion welding machine developed by American Babcock and Wilcox; long coated electrodes $^1/_4$ in. in diam were mechanically fed to arc from traveling arm of machine; complete weld can be made at rate of 1 ft per hr for plates up to 1 in. thick.

BOLTS AND NUTS

LOCKING DEVICES. Machine Fastenings May Spell Failure or Success, H. B. Veith. Machine Design v 4 n 7 July 1932 p 32–5. Principles of special locked fastenings employing unique combinations to hold bolts, nuts, and other machine parts against vibration or impact.

BORING MILLS

PROPELLER - BOSS MACHINING. Machining Propeller Bosses on Extension Type Boring Mill. Machy (Lond) v 40 n 1031 July 14 1932 p 463–6. Design and operation of special machine built by G. Richards & Co., Broadheath, for machining bosses of all types of propellers, including those for largest ships.

BRONZE

PROPERTIES. Directional Properties in Cold-rolled and Annealed Commercial Bronze, A. Phillips and C. H. Samans. Am Inst Min and Met Engrs—Tech Pub n 491 mtg Oct 1932 12 p. Tests on specimens containing copper 90.08 per cent, zinc 9.88, lead 0.012 and iron 0.030, commonly known as commercial bronze; comparison of results with those from similar tests on copper.

CAR BRAKES

TESTING. Brake Tests Point Way to Faster Schedules, F. T. Ward. Transit J v 76 n 8 Aug 1932 p 346–9. Series of experiments conducted by Third Avenue Railway, New York, makes possible reduction of 36 per cent in stopping distance; tabular and graphical review of brake test results; diagrammatic arrangement of standard brake piping used on Third Avenue cars.

CARS, FREIGHT

STEEL. All-Steel Box-Car Design Presented to Mechanical Division. Ry Mech Engr v 106 n 8 Aug 1932 p 317–23. Design for steel-sheathed wood-lined car for generally unrestricted interchange service differs materially from that originally presented before Mechanical Division in 1923; Car Construction Committee estimates saving in weight of $1^1/_2$ tons; diagrams of base car equipped with latest designs of proprietary doors, ends and roofs; weight comparisons; calculated stresses; underframe design.

CARS, PASSENGER

AIR CONDITIONING. All-Electric Air Conditioning for Illinois Central. Ry Elec Engr v 23 n 8 Aug 1932 p 183–5; see also Ry Mech Engr v 106 n 8 Aug 1932 p 305–8. System employs 15-kw axle generator and a-c—d-c motor drive for compressor which will charge batteries when car is standing in terminals; characteristics of following: axle generator, gear drive for generator, generator control, refrigerating system, air-conditioning units, air-duct construction.

CAR-WASHING EQUIPMENT. Spray Washing Passenger-Car Sash. Ry Mech Engr v 106 n 7 July 1932 p 287–9. Spray equipment recently installed at Milwaukee (Wis.) shops of Chicago, Milwaukee, St. Paul & Pacific for washing sash, doors and other parts removed from cars is made and assembled, except for hose and nozzles, from second-hand material; details of equipment and methods employed; time study made of spray washing sash, doors and trimmings from steel coach.

CARS, TANK

DRY BULK COMMODITIES. Tank Car for Handling Dry Bulk Commodities. Ry Mech Engr v 106 n 9 Sept 1932 p 360–1. General American Tank Car Corp has recently developed "Dry-Flo" tank car, designed to handle such dry bulk commodities as cement, lime, silica sands, sulphur, fertilizers, soda ash, potter's clays, fuller's earth, etc.; principal dimensions in table and drawings.

CAST IRON

GROWTH. Untersuchungen ueber das Wachsen von Gusseisen, E. Scheil. Archiv fuer das Eisenhuettenwesen v 6 n 2 Aug 1932 p 61–7. Investigation of growth of cast iron; influence of annealing at 600 C in air on cast-iron test bars of 5 to 100 mm diam; changes in structure by disintegration of cementite at edge and in middle, and by oxidation at edge; discovery of constituent consisting probably of ferrite and silicate; determination of volume change by cementite disintegration.

NITRIDED. Hardening Cast Iron, J. E. Hurst. Foundry Trade J v 47 n 831 p 37–41 (discussion) July 28 p 54–5. Hardened and tempered cast iron and nitrogen-hardened cast iron; effect of

hardening and tempering on Brinell hardness and ultimate breaking strength of cast iron; machining operations in manufacture of hardened and tempered cylinder liners; "Nitricast iron" valve castings; production of hardened and tempered castings; nitrogen-hardening treatment. Before Inst. Brit. Foundrymen.

CASTINGS

LIGHT-METAL. Schrumpfrisse in einem Leichtmetallgusstueck als Folge des Eingiessens einer Lagerbuechse, M. Widemann. Giesserei v 19 n 33/34 Aug 19 1932 p 332–3. Practical example is given which shows that casting of bearing bush inside of light-metal thin-walled casting of box shape causes unpreventable shrinkage cracks; therefore guarantee for such castings, if subjected to vibration stresses of high frequency, cannot be given.

CHAINS

MANUFACTURE. Manufacture of Cast Steel Chains at Baltic Plant, S. Gladin. Sudokhodstvo i Sudostroyeniye n 4–5 (6–7) Apr-May 1932 p 211–12. Description of processes of making heavy-duty anchor chains; tests of product. (In Russian.)

CHROMIUM-NICKEL ALLOYS

HEAT-RESISTING. Waermefeste Speziallegierungen (Nickel - Chrome - Eisen - Gruppe), W. Herrmann. Feuerungstechnik v 20 n 8 Aug 15 1932 p 114–16. Properties of heat-resisting special alloys of nickel-Chromium-iron group; review of recent investigations; article has reference to nickel-chromium alloys to which iron has been added to extent of 30 to 40 per cent for purpose of obtaining certain technical properties and for reducing manufacturing price; table giving composition of best-known alloys of this type.

CLUTCHES

CENTRIFUGAL. Time—Torque—Acceleration in Centrifugal Clutches, L. J. McDonnough and E. Neiderer. Product Eng v 3 n 8 Aug 1932 p 337–8. Determination of time required for acceleration and maximum accelerating torque, for proper proportioning of component parts; theoretical analysis of mechanics of typical centrifugal clutch; speed, time, and torque data; effect of varying spring pressure or moment of inertia, on time for acceleration.

CRANES

FLOATING. Pontoon Crane for Durban Harbour. Engineer v 154 n 3998 Aug 26 1932 p 216. Self-propelling crane with pontoon 150 ft long with beam of 50 ft and depth of 11 ft 6 in.; built on longitudinal system; propelling machinery comprises twin-screw arrangement of triple-expansion steam engines; crane has lifting capacity of 25 tons with max working radius of 80 ft.

CYLINDERS

THIN-WALLED, STRENGTH OF. Strength Tests on Thin-Walled Duralumin Cylinders in Torsion, E. E. Lundquist. Nat Advisory Committee Aeronautics—Tech Notes v 427 Aug 1932 8 p 12 supp sheets. Results from torsion (pure shear) tests on 65 thin-walled duralumin cylinders of circular section with ends clamped to rigid bulkheads; effect of variations in length per radius and radius per thickness ratios on type of failure; semi-empirical equation for shearing stress at maximum load.

DIES

FORGING. Forging Dies Made From Master Types, R. H. McCarroll. Metal Progress v 22 n 1 July 1932 p 38–40. Die typing as practiced by Ford Motor Co.; master type good for 200 to 400 forging dies.

Typed Forging Dies Have Longer Life and Cost Less to Make, E. F. Ross. Steel v 91 n 7 Aug 15 1932 p 21–3. Methods of Ford Motor Co. of making light hammer and press forging dies, trimming dies and dies for molding plastics; dies produce about 25 per cent more forgings, as compared with dies turned out by die sinking.

PUNCHING. Cheap Construction of Complicated Punches and Dies. Machy (Lond.) v 40 n 1029 June 30 1932 p 393–4. Method for building up dies and punches from separate pieces by locating pieces in recesses in base block and holding them in position with material of low-melting point poured around; properties of low-melting-point alloys.

DIESEL ENGINES

AUTOMOTIVE. Allen Locomotive Diesel Engine. Gas and Oil Power v 27 n 322 July 1932 p 156–7. General review of design and construction details of Allen rail traction engine which developed 150 bhp at 550 rpm; transverse and sectional diagrams.

Benz High-Speed Diesel for Trucks, E. P. A. Heinze. Diesel Power v 10 n 8 Aug 1932 p 343. Design, construction and operating characteristics of new Daimler-Benz Diesel engine which develops 55 hp at 2000 rpm and consumes 0.444 b per hp-hr.

Der Schweroeimotor im Nutzkraftwagen, F. Eichelhardt and F. Strommenger. Automobiltechnische Zeit v 35 n 12 June 25 1932 p 305–7. Economic advantages of Diesel engines for operation of motor trucks, motor buses and tractors as compared to carburetor engines.

High-Speed Compression-Ignition Engines, C. B. Dicksee. Automobile Engr v 22 n 294 and 295 June 1932 p 285–91 and July p 333–8. June: Problems in utilizing oxygen available within cylinder and for avoiding production of smoke, noise and smell; compression-ratios and compression temperatures. July: Effect of advancing injection on delay period; influence of compression temperature; effect of ignition advance on brake mep; suitability of fuel from point of view of knocking, etc.

New Diesel Engine, O. Schwager. Automobile Engr v 22 n 294 June 1932 p 277–81. Design and performance characteristics of engine with heart-shaped combustion chamber; test results of experimental engine of 2.95 by 6.30 in. bore and stroke, developing 8 hp at 1400 rpm; compression ratio 12.78; mep 125 lb.

BURMEISTER AND WAIN. 22,500 B.Hp. Oil Engine. Brit Motor Ship v 13 n 151 Sept 1932 p 197–202. Double-acting 2-stroke Burmeister and Wain engines for stationary purposes; design is identical to that of marine unit; 8 cylinders have diam of 840 mm; piston stroke 1500 mm; speed 115 rpm; equipped with oscillation damper and scavenging blowers.

COMBUSTION. Untersuchungen an der Dieselmaschine, K. Neumann. VDI Zeit v 76 n 32 Aug 6 1932 p 765–70. Theoretical analysis of physical and chemical phenomena controlling ignition process with particular regard to heat transfer, heat of chemical reaction and affinity between oxygen and fuel; effect of oxygen concentration, air density and temperature on time; calculation of oxygen requirements and speed of reaction on basis of kinetic considerations.

DORMAN. Dorman-Ricardo Compression Ignition Engines. Engineer v 154 n 3997 Aug 19 1932 p 189–90. Ricardo Comet type of combustion chamber has primary object of obtaining high power output and efficiency with clean and odorless exhaust; claim of high power and efficiency is borne out by power curves, one of which is reproduced; standard type of Bosch fuel pump is driven at half engine speed by means of helical gearing.

FUEL INJECTION. Preliminary Photomicrographic Studies of Fuel Sprays, D. W. Lee and R. C. Spencer. Nat Advisory Committee Aeronautics—Tech Notes n 424 July 1932 7 p 6 supp sheets. Photomicrographs of fuel sprays injected into air at various densities for purpose of studying spray structure and stages in atomization; dispersion of fuel spray at given distance from nozzle increases with increase in jet velocity or increase in air density.

HIGH-SPEED. Marshall High-Speed Heavy-Oil Engine. Gas and Oil Power v 27 n 322 July 1932 p 145–7. Design and constructional details of light-weight engines manufactured by Marshall, Sons & Co., Ltd. Britannia Iron Works, Gainsborough; new engines develop 40 bhp per cyl at 750 rpm; sectional diagrams and performance curves.

SUPERCHARGING. Les moteurs Diesel marins suralimentés en Angleterre, Dombrowshi. Arts et Métiers v 85 n 141 June 1932 p 207–12. Comparison of design and operating characteristics of British and French installations with particular regard to utilization of exhaust-gas heat in generating steam for operating supercharger by turbine.

VIBRATIONS. Torsional Vibration Characteristics of Six-Cylinder Four-Stroke Cycle Single-Acting Oil Engines, W. K. Wilson. Gas and Oil Power v 27 n 323 Aug 1932 p 168–74. Methods available for modifying torsional vibration characteristics of given system; methods of altering natural frequencies of torsional vibration of any given system; vibration stress values; methods of modifying torsional vibration stresses in marine installations; curves illustrating torsional-vibration characteristics.

EXTENSOMETERS

TYPES. L'etude des déformations locales et les méthodes pratiques de sa réalisation, G. Ivanow. Sicence et Industrie v 16 n 221 and 222 June 1932 p 237–40 and July p 287–91. Methods of studying local deformation in parts of machinery, boilers, airplanes, etc. with particular regard to use of various types of extensometers by Huggenberger, Martens-Kennedy and Ritz.

FLOW OF FLUIDS

MEASUREMENT. Schwimmer-Manometer mit mechanischer Radizierung fuer Durchflussmessung, G. Ruppel. Archiv fuer Technisches Messen v 1 n 7 Jan 1932 p T 10 (4 p). Design and operating principles of flow meters incorporating mechanism for extracting square root in connection with automatic recording; determination of errors.

Ueber die Messung von Geschwindigkeit und Druck in einer dreidimensionalen Stroemung, F. Krisam. Zeit fuer Flugtechnik und Motorluftschiffahrt v 23 n 13 July 14 1932 p 369–73. Experimental investigation of method of measuring velocity and pressure in 3-dimensional flow by means of van der Hegge Zijnen sphere; calibration and determination of error.

PIPES. Determining Friction Losses in Piping Systems, M. J. Reed and L. H. Morrison. Chem & Met Eng v 39 n 8 Aug 1932 p 446–8. Chart showing relations of kinematic viscosity and friction factor for various rates of flow and conditions and kinds of pipe; curves suitable for liquids and gases.

FOUNDRIES

GREAT BRITAIN. New Mechanised Foundry of Messrs. Ferranti, Limited. Foundry Trade J v 47 n 833 Aug 4 1932 p 65–9. Foundry at Hollinwood, Lancashire; melting plant; charging; continuous casting plant; cupola-charging platform; melting equipment; regulation of speed of production; loose-pattern iron and nonferrous castings; core making.

GAS PRODUCERS

COKE. Untersuchungen an einem Hochdruck dampfkessel generator ueber den Einfluss der Leistungsveraenderung, E. Hecker. Gas und Wasserfach v 75 n 18 Apr 30 1932 p 329–35. Tests on gas producer for high-pressure boiler with particular regard to determination of effect of thermal efficiency and heat balance on steam output.

GAS TURBINES

GAS-STEAM. La turbina semi-gas, M. Dornig. Elettricista v 41 n 3 Mar 31 1932 p 29–34. Thermodynamic study of possibility of obtaining efficiency of 40 to 50 per cent in turbine using internal-combustion principle in combination with steam.

GASOLINE ENGINES

DESIGN. Entwicklung und Entwicklungsstand der Leichtoel-Motoren fuer Fahrzeuge und Flugzeuge, W. Schwerdtfeger. Automobiltechnische Zeit v 35 n 14 July 25 1932 p 348–50. Trends in design of gasoline engines compared on basis of performance and dimensions of representative makes of air- and water-cooled aircraft, automobile, and motor-truck engines.

GEARS

CUTTERS. Effect of Pressure Angle on Cutting Tools, S. Trimbath. Am Mach v 76 n 26 July 6 1932 p 825–6. Comparison of profiles for both gears and cutters shows how cutting action becomes concentrated on smaller length of cutter tooth profile, as operating pressure angle decreases; application to certain types of gear tooth grinder.

GEAR-CUTTING MACHINES. "Shaving" Process Used to Cut Gear-Making Cost, A. F. Denham. Automotive Industries v 67 n 10 Sept 3 1932 p 304–5. Operating accuracy of machine developed by Michigan Tool Co. of Detroit, for rapid finishing of spur or helical gears; tolerances for transmission gears.

HARDENING. Hardening Large Gear Wheels. Engineer v 154 n 3997 Aug 19 1932 p 191. Latest and largest machine supplied for hardening gears by Shorter process made by Patent Gear and Metal Hardening Co. and installed in Darlaston works of Wellman Smith Owen Engineering Corp.; machine is capable of handling gear wheels up to 6 ft 4 in. in diam with tooth face of 24 in. with circular pitch of $^3/_8$ in. or more.

INVOLUTE. Number and proportions of Involute Teeth, M. Naruse. Tohoku Imperial Univ—Technology Reports v 10 n 3 1932 p 335–63. Derivation of formulas for determining number and dimensions of teeth with particular regard to specific sliding, gear ratio, and pressure angle, together with mutual interference of teeth, number of pairs of teeth in contact, and thickness of teeth measured on addendum circle; graphical representations of formulas and numerical examples.

GRINDING MACHINES

DESIGN. Aufgaben des Schleifmaschinenbaus. K. Reinecker. VDI Zeit v 76 n 30 July 23 1932 p 725–8. Contribution to 100th anniversary of J. E. Reinecker birthday; modern principles of grinding machine design illustrated by representative types of J. E. Reinecker, A.-G., Chemnitz.

HEAT-INSULATING MATERIALS

ALUMINUM FOIL. Aluminium as Heat Insulating Material. Chem Age v 27 n 687 Aug 27 1932 p 191–2. Article based on information supplied by British Aluminium Co., and Alfol Insulation, Ltd., describes new development in heat insulating materials; advantages of Alfol system.

APPLICATIONS. Thermal Insulation and Insulating Materials. Chem Age v 27 n 676 Aug 27 1932 p 199–202. Means of reducing loss of heat by radiation and convection from furnaces, still, storage tanks, reaction chambers of similar plants in chemical industry; evaluation of insulating materials; testing methods; shrinkage and fusion point; use of cork; conservatism of heat at high temperatures; jointing materials.

HEAT TRANSMISSION

FINS. Transmission de la chaleur par les tubes à ailettes. E. Rauber. Science et Industrie v 16 n 222 July 1932 p 261–6. Mathematical analysis pertaining to transmission of heat through externally ribbed tubes.

PLATES. Flow of Heat Through Plates. R. Ruedy. Can J Research v 6 n 6 June 1932 p 577–83. Speed is calculated with which steady flow of heat is established in slab of uniform temperature after one boundary plane has been suddenly brought to higher temperature, or when temperature of both planes is changed; flow of heat expressed by means of simple theta functions.

MEASUREMENTS. Mesure du coefficient d'échange thermique entre une paroi solide et un courant gazeux. E. Brun and P. Vernotie. Academie des Sciences—C R v 195 n 4 July 25 1932 p 302–4. Determination of coefficient of transfer of heat between solid wall and gas current.

HONING MACHINES

NEW TYPE. New Honing Equipment. Automobile Engr v 22 n 294 June 1932 p 268. Single spindle machine manufactured by Kitchen and Wade, Ltd., Halifax with spindle speeds from 320 to 180 rpm, strokes per min can be varied between 90 and 50; 2-spindle machine by Cunliffe and Croom, Ltd., Broughton Iron Works, Manchester with stroke between 4 in. and zero, spindles revolve at 400 rpm with 80 strokes per min.

HYDRAULIC LABORATORIES

FRANCE. Testing Laboratory of French Hydrotechnical Society at Beauvert, near Grenoble (France), D. Cahuzac. Electra n 7 June–July 1932 p 119–23. Society deals especially with problems encountered by manufacturers of hydraulic machinery and users of water falls; testing laboratory at Beauvert, in proximity to artificial lake, purpose of which is to carry out hydraulic research. (In English and French.)

HYDRAULIC TURBINES

CAVITATION. Cavitation—Its Cause and Influence on Hydraulic Turbine Design. Power Plant Eng v 36 n 17 Sept 1932 p 674–6. General review of practice and methods for elimination of cavitation; formulas developed by W. Spannhake pertaining to elements causing cavitation; testing equipment and methods.

TESTING. Die neue Einrichtung des hydraulischen Instituts im Maschinenlaboratorium der Technischen Hochschule Dresden, A. Reinhardt. VDI Zeit v 76 n 32 Aug 6 1932 p 776. Description of recently installed turbine-testing unit of mechanical laboratory of Department of Hydraulics of Dresden Institute of Technology.

HYDROELECTRIC POWER DEVELOPMENTS

COST ESTIMATING. Segregation of Hydroelectric Power Costs, W. S. McCrea, Jr. Am Inst Elec Engrs—Advance Paper n 32-112 mtg Aug 30-Sept 1932 8 p. Outline of method used in segregating system power costs and development of fundamental cost items; segregation of power costs of hydroelectric stations into their component parts; peculiarities of hydro power; method of determining average cost of power for hydro unit or hydro system.

HYDROELECTRIC POWER PLANTS

UNITED STATES. Rock Island Hydroelectric Development, A. P. Newberry and G. C. Sears. Elec Eng v 51 n 9 Sept 1932 p 654–9. Initial 60,000-kw Rock Island plant is first major low-head installation on Pacific Coast; territory has largest installed capacity in adjustable-vane propeller-type wheels of any plant in United States; some of project's many departures from conventional design are illustrated.

INDUSTRIAL MANAGEMENT

BASIC PRINCIPLES. Buyers Want Better Values, A. G. Ashcroft. Factory and Indus Mgmt v 83 n 7 July 1932 p 269–71. How rug manufacturer organized product development and control department to meet demands of better and better goods which suit today's pocketbooks; basic principles of scientific management; major items of product development and control; organization requirements.

FATIGUE. Rationalisation of Manual Labour by Industrial Physiology. R. Leonhardt. Foundry Trade J v 47 n 835 Aug 18 1932 p 97–8. Review of experiments performed on expenditure of energy during work, with special reference to experiments with respiration apparatus by E. Simonson, in foundry at Frankfurt-on-Main, Germany, showing that better performance which rationalized management boasts of is obtained at cost of increased expenditure of energy (body fatigue).

MOTION STUDY. Motion Study in Job Shop, E. L. Berry and H. C. Robson. Factory and Indus Mgmt v 83 n 7 July 1932 p 285–7. Consideration of factors pertaining to motion-study equipment and methods employed in job shop of Link-Belt Co., Chicago; simultaneous motion-cycle charts; advantageous results from efficient motion studies.

PRODUCTION CONTROL. Novel Method of Production Timing, O. J. Poupitch. Instruments v 5 n 7 July 1932 p 165 and 168. Production is recorded on wax impregnated paper tape which is moved through punching mechanism at uniform rate of approximately 1/4 in. per min; punching device is actuated upon completion of finished unit which passes through chute adjacent to operator.

TIME STUDY. Measuring Human Element in Industry—I. N. G. Mills. Mill and Factory v 11 n 2 Aug 1932 p 21–4. Consideration of factors pertaining to relative value in various classes of work at Westinghouse Electric Mfg. Co.; methods of recording time studies; time study sheets.

When Pieceworker Runs Several Machines, D. W. Pinkerton. Am Mach v 76 n 26 July 6 1932 p 816–18. Economic methods of establishing fair rates for operator, regardless of kind or number of machines he is given to operate, size of orders, or type of work; assumptions regarding operating conditions.

WAGE INCENTIVES. Tool Costs Too High? Try Wage Incentives, R. F. Niller. Factory and Indus Mgmt v 83 n 7 July 1932 p 279–82. With trend toward use of high-speed semi-automatic and full-automatic machinery; direct-labor manufacturing costs are proportionately decreasing, whereas tool costs are mounting; practical review of methods which will help to control and decrease tool costs.

INTERNAL-COMBUSTION ENGINES

COMBUSTION. Experiments Show Half of Fuel Wasted Through Exhaust, O. P. Van Steewen. Automotive Industries v 67 n 7 Aug 13 1932 p 198–201. Diagram of mechanism of combustion of hexane and ethane; economic aspect of incomplete combustion; relation between diameters of droplets and their frequency in spray; test equipment for microphotography of combustible mixtures for spark-ignition engines.

SCAVENGING. Massnahmen zur Erhoehung der Literleistung und der Wirtschaftlichkeit bei Zweitaktmotoren, H. J. Venediger. Automobiltechnische Zeit v 35 n 10 and 12 May 25 1932 p 249–51 and June 25 p 301–3. Design measures for increasing specific output and efficiency of 2-cycle engines with particular regard to use of stepped pistons; calculation of efficiency of scavenging process.

Zweitaktmotor ohne Spuelverluste, P. Schauer. Automobiltechnische Zeit v 35 n 15 Aug 10 1932 p 372–5. Design and operating principles of engine developed by author with fuel consumption almost equal to 4-cycle engine; control of scavenging process by piston operated from crankshaft in small bore at slight angle to cylinder.

STARTING. Anwerfen von Explosionsmotoren mittels Druckluft, H. Heck. Automobiltechnische Zeit v 35 n 15 Aug 10 1932 p 375–6. Operating principles of equipment for starting internal-combustion engines by means of compressed air, comprising small reciprocating compressor, air container, and pneumatic starting motor.

[See also *Airplane Engines; Automobile Engines; Diesel Engines; Gasoline Engines; Motor-Truck Engines; Oil Engines.*]

IRON AND STEEL PLANTS

CRANES AND CONVEYORS IN. Der elektrische Antrieb von Huettenwerkskranen und Walzwerks-Hilfsmaschinen, H. Gettert. Foerdertechnik und Frachtverkehr v 25 n 13/14 July 1 1932 p 147–8. Electric drive of cranes for metallurgical plants and auxiliary machinery in roller mills; new viewpoints for planning; choice of control equipment and systems for their connection; difficulties to be overcome in electric braking; protection.

Moving Materials by Conveyors, C. A. Adams. Blast Furnace & Steel Plant v 20 n 8 Aug 1932 p 655–7. Examples of recent installations of conveyors in large steel plants throughout United States.

LATHES

ELECTRIC DRIVE. Electrical Equipment of Heavy Machine Tools, D. D. Rayner. Elec Times v 82 n 2130 Aug 18 1932 p 198–9. Equipping locomotive wheel lathe, which may involve as many as seven distinct motions, each of which is carried out by means of separate motor designed especially for its respective duty with suitable motors.

LOCOMOTIVES

DIESEL. Fortschritte und Aussichten des Diesel lokomotivbaus unter besondrer Beruecksichtigung der Diesel-Druckluft lokomotive der Deutschen Reichsbahn, M. Mayer. VDI Zeit v 76 n 29 July 16 1932 p 705–9. Progress in development of Diesel locomotives with electric and pneumatic power transmission with particular regard to compressed air transmission of German State Railroad.

Transmissions for Diesel Locomotives and Railcars, S. Miall. Ry Gaz v 57 n 7 Aug 12 1932 p 197–8. Final drive by worm gearing; gears of cylindrical worm type; gears of hollow-worm type.

DIESEL - ELECTRIC. A - W Diesel - Electric Shunting Locomotive. Gas and Oil Power v 27 n 322 July 1932 p 151. General review of 40-ton 6-coupled Diesel-electric switching locomotive which is undergoing extensive trials on L.N.E.R.; locomotive equipped with 6-cyl 4-stroke cycle airless-injection Diesel engine.

Diesel-Electric Locomotives for Denmark. Ry Gaz v 57 n 7 Aug 12 1932 p 194–6. Danish State Railways have taken delivery of two 1000-bhp 484-type, Frichs units; weight in service 100 t 7 cwt. rigid wheelbase 15 ft 3 in.; driven by two Frichs 6-cyl 4-stroke Diesel engines; each generator is directly coupled to its Diesel engine and supplies current for two traction motors.

LUBRICATING OILS

PROPERTIES. Properties of Lubricating Oils, T. Namikawa. Soc Chem Industry, Japan—J v 35 n 7 July 1932 p 719–22; see also English abstract in supp binding of same issue p 271B–3B. Investigation of oils for direct-coupled steam-turbine and reciprocating steam-engine use, for geared steam-turbine use and for refrigerating machine.

LUBRICATION

BOUNDARY. Boundary Lubrication, W. E. Campbell. Bell Laboratories Rec v 10 n 12 Aug 1932 p 406–11. Simple linear relationships between coefficient of static friction and molecular weight for some of normal paraffin hydrocarbons and normal fatty acids used as lubricants; experiments with widely differing bearing surfaces represented by glass on glass, bronze on bronze, steel on steel.

MACHINE TOOLS

ELECTRIC DRIVE. Considerations sur l'équipement électrique des grosses machines-outils modernes, J. M. Herve. Assn des Ingénieurs Electriciens Sortis de l'Institut Electrotechnique Montefiore-Bul v 10 n 6 June 1932 p 167–88. Electric drive of large modern machine tools; fundamentals for planning; speed regulation and kind of current to be used; location of motors; particulars of equipment.

HYDRAULIC DRIVE. Automatic Loaders for Groups of Machines. Machy (Lond.) v 40 n 1037 Aug 25 1932 p 645–9. Automatic work loading and unloading devices installed at Newcastle plant of Chrysler Corp., for centering, rough-turning and facing, and finish turning and facing motorcar steering-gear sector shafts.

TESTING. Inspection and Testing of Machine Tools, G. Schlesinger. Machy (Lond.) v 40 n 1032 July 21 1932 p 506–8. Test charts for power presses, punching machines, and shearing machines, with data on permissible errors and tolerances of principal machine parts.

MACHINERY

DYNAMICS. Graphical Analysis of Impact in

Mechanical Movements, G. F. Nordenholt. Product Eng v 3 n 7 July 1932 p 273–6. Outline of simple method for graphical analysis of magnitude and rapidity of fluctuation of forces in mechanical movements; need of analysis with increasing demand for speed.

MALLEABLE-IRON CASTINGS

SPECIFICATIONS. Résumé of Work of Malleable Iron Sub-Committee of Institute of British Foundrymen. Foundry Trade J v 47 n 831 and 832 July 21 1932 p 31–3 and July 28 p 47–51. Record of work of Subcommittee to date (May 1932); B.E.S.A. (B.S.I.) Specifications Nos. 309 and 310, 1927; use of varied-sized test bars with standard requirements; varied grades of malleable; electromagnetic properties; microscopical examination, specification and correlation with mechanical properties, etc. Bibliography.

METALS

DEFORMATION. Flow of Solid Metal Aggregates, C. H. M. Jenkins. J Rheology v 3 n 3 July 1932 p 289–97. Internal changes in metal subjected at suitable temperature to steady stress sufficiently high to produce flow and rupture; strength of metals at high temperatures compared with that of other metals at atmospheric temperatures; connection between flow and previous condition of metal, i.e., whether cast or worked, etc., is related to microstructure and grain size. Bibliography.

EROSION-RESISTING. Accelerated Tests Reveal Erosion-Resisting Metals, T. F. Hengstenberg. Power v 76 n 3 Sept 1932 p 118–20. Specimens of various metals whirled past water jet at speeds up to 1200 ft per second show test results that agree closely with their actual erosion as machine parts in commercial service; test specimens; outline of test procedure; summary of test results.

TEMPERATURE EFFECT. Creep Characteristics of Metals at Elevated Temperatures, A. E. White and C. L. Clark. Am Soc Steel Testing—Advance Paper n 5 mtg Oct 3–7 1932 16 p. Historical development of physical testing, leading up to creep tests; creep-testing equipment at University of Michigan; methods employed in plotting of data; influence of grain size, chemical composition, methods of manufacture, heat treatment and rate of creep.

Essais des métaux aux températures élevées, J. Galibourg. Revue de Métallurgie v 29 n 7 July 1932 p 377–9. Testing of metals at high temperatures. Paper before International Congress for Testing Materials, Zurich.

MOTOR-TRUCK ENGINES

GENERAL MOTORS. New Engine for General Motors Trucks Line Shows Exceptional Torque Ability, A. F. Denham. Automotive Industries v 67 n 10 Sept 3 1932 p 294–6. Design of 6-cyl engine of 400.9 cu in. of piston displacement, with torque curve which shows 296 lb ft or better from 800 to 1600 rpm; bore and stroke of $4^1/_8$ by 5 in.; 112.5 hp at 2800 rpm.

NON-FERROUS METALS

LIGHT. Dynamische Festigkeitseigenschaften einiger Leichtmetalle, K. Matthaes. Zeit fuer Metallkunde v 24 n 8 Aug 1932 p 176–80. Dynamic-strength properties of some light metals; tests on aluminum and magnesium alloys; experience in investigating static properties; impact resistance; endurance bending strength; tests with DVL plane bending machine; corrosion fatigue in relation to surface protection (anodic oxidation).

OIL ENGINES

AUTOMOTIVE. Oil Engines in Omnibus Practice in Germany, R. F. Fryars. Tramway and Ry World v 72 n 8 Aug 11 1932 p 107–8. Brief review of oil-engine industry in Germany; suggestion to British managements; oil-engine popularity; purchased out of fuel savings; hydrogen-gas-fuel mystery.

PLASTICITY

MECHANICS OF. Studier oever spaenningsfoerdelningen i omgivningen av kroppars kontakt jaemte tillaempningar, G. Lundberg and F. K. G. Odqvist. Ingenioers Vetenskaps Akademien—Handlingar n 116 1932 p 1–59; see also brief translated abstract p 60–4 2 supp plates. Researches into stress distribution in neighborhood of contact of solids with applications; combination of Hertz theory of elastic contact with recent theory of plastic-elastic equilibrium by H. Hencky.

PRESSES

MULTIPLE - OPERATION. Automatic Multi-Operation Press. Engineering v 134 n 3447 Sept 2 1932 p 266–8. Hilo press made by Hiltmann and Lorenz, Saxony, will handle blanks up to 7.87 in. in diam by 0.196 in. thick and will draw work of any depth up to 5.9 in.; feed is automatic and may be either strip metal or prepared blanks.

PRESSURE-MEASURING INSTRUMENTS

CORVOMETER. Das Corvometer, H. Rabe. Gas und Wasserfach v 75 n 16 Apr 16 1932 p 294–5. Construction and operation of compact instrument, the so-called Goeckel corvometer, for measurement and control of pressure, draft and velocity of gases and liquids.

PUMPING PLANTS

TESTING. Computing Pump Efficiencies by Direct Testing Measurement, T. G. Myers. Water Works Eng v 85 n 15 July 27 1932 p 918, and 921–22. Variations between calculated and actual test efficiencies of pumps and motor installations; how conventional efficiency is computed; method of directly measuring efficiency; equipment necessary for making tests.

PUMPS

CENTRIFUGAL BOILER FEED. Performance Characteristics of Centrifugal Boiler Feed Pumps, J. G. Mingle. Combustion v 4 n 1 and 2 July 1932 p 15–19 and Aug p 13–18. July: Practical discussion of centrifugal boiler-feed-pump performance; equations and charts; equations given for ascertaining various pump efficiencies. Aug: Nature of various curves of pump performance, interpreting significance of curve shapes and showing advantages and disadvantages of particular curve characteristics.

PUNCH PRESSES

ENERGY REQUIREMENTS. Energy Requirements and Motor Selection for Power Presses, W. M. Evarts, Jr. Metal Stampings v 5 n 4–8 Apr 1932 p 271–4, May p 339–42 and 52, June p 403–6 and 418, July p 459–62, and Aug p 511–15. Apr.: Distinction between power and energy important in motorization of presses; flywheel energy should be calculated for each job. May: Gearing permits use of smaller and lighter flywheels which often have distinct advantage. June: Job energy requirement and press operating speed not sufficient data for determination of power requirement. July: Examples are typical problems in motorization of presses. Aug: Test in which complete data was gathered on press in operation.

RAIL MOTOR CARS

DIESEL-ELECTRIC. Automotrices thermo-électriques, F. Gelber. Traction Électrique v 3 n 6 June 1932 p 71–4. Development of high-powered Diesel-electric rail motor cars from 150 hp and more; types of engines; equipment for electric transmission and its advantages; motor cars of 250 hp of Swiss Federal railroad and 180 hp of Italian State railroad illustrated.

GASOLINE-ELECTRIC. Santa Fe Gets Most Powerful Rail Car Yet Built. Ry Age v 93 n 3 July 16 1932 p 78–80. Atchison, Topeka & Santa Fe placed in service largest and most powerful rail car of gas-electric type yet constructed; articulated unit, 90 ft long, develops 900 hp; designed for speeds up to 80 mph; articulated construction designed for safety and flexibility; fire hazard from backfiring eliminated; traction motors of new design.

RAILROAD TRAIN CONTROL

AUTOMATIC STOP. Kofler Automatic Train Stop. Ry Gaz v 57 n 9 Aug 26 1932 p 249–50. New all-mechanical system on trial on Isar Valley line, in neighborhood of Munich; it is claimed that Kofler system offers reliable method of carrying out automatic train control by mechanical means on main-line railways.

REFRIGERANTS

NEW TYPES. Neue Kaeltemittel, R. Plank. Zeit fuer die gesamte Kaelte-Industrie v 39 n 7 and 8 July 1932 p 133–6 and Aug p 154–8 supp plate. July: Analysis and properties of some new refrigerants; chlorine-fluoride derivatives of methane. Aug. Vapor tables and Mollier chart for dichlorodifluoromethane; methyl formiate; dimethyl ether; sulphur hexafluoride.

REFRIGERATING MACHINERY

ABSORPTION MACHINE. Untersuchung an einer zweistufigen Ammoniak-Absorptions-Kaeltemaschine System Dr. Altenkirch, M. Gompertz and W. Niebergall. Zeit fuer die gesamte Kaelte-Industrie v 39 n 8 Aug 1932 p 158–60. Investigation of two-stage ammonia absorption refrigerating machine according to Dr. Altenkirch system; investigation of causes of heat losses; setting up heat balance.

DOUBLE - PIPE CONDENSERS. Double - Pipe Condensers for Refrigerating Plants, W. S. Douglas and J. S. Westcott. Engineering v 134 n 3476 Aug 26 1932 p 235–6. Method of calculation of heat transmission surfaces which applies equally to multi-pass or multi-tubular condensers where number of smaller water tubes pass through outer pipe.

RIVETED JOINTS

TESTING. Efficiency of Wide Plates. Boiler Maker v 32 n 7 and 8 July 1932 p 138–41 and Aug p 167. July: Section of plates tested at Engineering Experiment Station of University of Illinois, Urbana, Ill. varied from 40 in. by $^1/_4$ in. and $20^1/_2$ in. by $^1/_2$ in. to 72 in. by $^5/_8$ in.; outline of equipment, methods employed and results of measurements to determine variations in plate. Aug.: Continued discussion of tests on wide plates as used in construction of storage tanks for water and oil.

ROLLING MILLS

BLOOMING MILLS. Vorwalzenkalibrierungen und Kaliberanordnungen auf festliegenden Triowalzen, T. Dahl. Stahl und Eisen v 52 n 32 Aug 11 1932 p 779–83. Billet roll passes and pass arrangements on stationary three-high rolling mills; elimination of strains by proper design and arrangement of passes.

DESIGN. Anwendung kleinster Walzendurchmesser und Fortbildung von Mehrrollenwalzwerken, W. Rohn. Stahl und Eisen v 52 n 34 Aug 25 1932 p 821–5. Application of minimum roll diameter and development of multiple-roll mills; gripping capacities and deformation with thick and thin roll diameter; effect of too low and too high pressure with thin rolls on uniformity of rolled material; modern trend toward diminishing diameter of rolls; apparatus for testing rolling accuracy.

LUBRICATION. Roll Neck Lubricants and Lubrication, W. D. Hodson. Iron and Steel Engr v 9 n 6 June 1932 p 290–307. Lubrication of standard babbitt and bronze bearings, roller bearings, composition bearings, and hot neck bearings with particular regard to possible economy. Before Assn. Iron and Steel Elec Engrs.

SHEET MILLS — COUPLINGS. Kuppelspindel zum Antrieb von Blechstrassen. Stahl und Eisen v 52 n 31 Aug 4 1932 p 764–5. Friction coupling for drive of sheet mills, developed by Schloemann A. G., Duesseldorf, which can be changed from flexible to rigid spindle, or vice versa, during operation, by displacement of coupling link.

SAND, FOUNDRY

CONTROL. Control of Hardness and Other Mold Properties, H. W. Dietert. Am Foundrymen's Assn—Trans v 3 n 4 June 1932 p 63–70 and (discussion) 70–1. Control of sand condition in rammed mold; control of heap sand and casting defects; physical properties of sand in mold; definition of mold hardness and method of testing; effect of sand grain sizes on permeability and hardness.

SAWS

METAL-WORKING. Heavy-Duty Circular Cold Saw. Engineering v 134 n 3475 Aug 19 1932 p 208–10. Machine made by Gebrueder Heller, Wuertemberg, Germany, for trimming crankshaft forgings; machine is also suitable for handling heavy forgings or stock of large sizes; it is electrically driven.

WOODWORKING. Schaltwerke fuer Vollgatter, F. Braunshirn. VDI Zeit v 76 n 31 July 30 1932 p 751–5. Design of automatic feed-control mechanisms; use of indicator for comparing operating characteristics of representative designs.

SCREW THREADS

GAGES. Direct - Comparison Contour Projector. Engineering v 134 n 3476 Aug 26 1932 p 259. System for examining accuracy of contour of such parts as screw threads; instrument is designed for comparing actual parts, such as master and its copies without having to make either templet or drawing, though either can be used if desired; manufactured by E. Leitz, Wetzlar; it may be used for testing tooth profiles and pitch of gear wheels.

Gewinde-Messungen, G. Berndt. Archiv fuer Technisches Messen v 1 n 10 Apr 1932 p T52 (4 p). Fundamentals of measuring cylindrical thread with data on tolerances; comparison of accuracy and suitability of various gages.

SEAPLANES

PASSENGER. Development of Do. X, C. Dornier. Aircraft Eng v 4 n 42 Aug 1932 p 193–6. Account of results of $2^1/_2$ years' operational experience; power-plant weight analysis; comparison of actual load factors with those required by D.V.L. regulations; analysis of weight of structure and equipment; air speed as function of engine rpm and gross weight; curves of take-off times. Before Munich Tech. College.

SOLAR ENERGY

UTILIZATION OF. L'utilisation de la chaleur solaire et les possibilités d'exploitation du Sahara comme source de puissance motrice, J. Boisse de Black. Revue Industrielle v 62 n 2278 Sept 1932 p 449–53. Utilization of solar heat in Sahara Desert and possibility of practical application; average calorific value per square meter analyzed for various regions; first application by Pasteur in hospital at Colomb-Béchar for heating of baths.

SPEED REDUCERS

DIESEL - ENGINE DRIVES. Gear Reducers and Increasers for Diesel Engine Drive. Diesel Power v 10 n 8 Aug 1932 p 345. Application of herringbone gear drives to Diesel engines for transmission of power and conversion of speed to accommodate requirements of high speeds, driven units, usually involves conditions of high speed, high power, and small ratio; characteristics of link-belt herringbone speed increaser in Diesel engine drive in pumping station at Avaion, N. J.

SPRINGS

DESIGN. Sur le calcul des resorrts à boudin chargés transversalement, R. Marty. Académie des Sciences—C R v 195 n 2 July 11 1932 p 105–7. Theoretical mathematical discussion of design of helical springs, transversely loaded.

STANDARDIZATION

PREFERRED NUMBERS. Vers des Nombres Mormaux Internationaux, R. Feret. Genie Civil v 101 n 7 Aug 13 1932 p 156–8. Review of contributions by French standardization committees to problem of series of International preferred numbers; acceptance of any system of preferred numbers will be largely due to inherent logical merits and efficiency of propaganda in its favor.

STEAM

PRESSURE TRANSFORMERS. Das Koenemann-Verfahren zur Druckumformung und zur Krafterzeugung, E. Praetorius. Feuerungstechnik v 20 n 7 and 8 July 15 1932 p 100–2 and Aug 15 p 117–20. Koenemann process for pressure transformation and power generation; comparison between mechanical and thermal pressure transformation; physical principles of process; basic equations for calculation of Koenemann transformers; losses and efficiency; binary-vapor engine based on Koenemann process with ammonia and water as primary and secondary substances.

STEAM CONDENSERS

ECONOMIC CONDENSATE TEMPERATURE. Wirtschaftliche Kondensattemperatur, H. Schlicke. Waerme v 55 n 31 July 30 1932 p 534–5. Economic temperature for condensate; investigation of whether it is advisable to reach higher vacuum in cold-weather period and to cool condensate accordingly; or it is more economical to maintain uniform vacuum, so that condensate may be kept at same temperature regardless of season, thereby saving heat required for preheating of condensate or feedwater when it is cooled below condensation temperature.

SURFACE. Considérations sur les condenseurs par surface, P. Quinio. Arts et Métiers n 143 Aug 1932 p 292–9. Surface condensers; corrosion and erosion of tubes; electrolytic, hydrodynamic and mechanical disturbances; means for prevention.

TUBES. Aluminum-brass Condenser Tubes. Mech World v 92 n 2378 July 29 1932 p 106–7. Alumbro is registered trade name of aluminum brass employed by I.C.I. Metals Ltd. used in manufacture of condenser tubes; remarkable resistance to corrosion erosion claimed; avoidance of scaling when subjected to high temperatures; typical cases of experience gained in use of these tubes.

WATER TREATMENT. Die Abscheidung von Oel-, Benzin- und Benzolresten aus Kondenswasser mit Aktiv-Kohle, M. Jaenicke. Chemiker-Ztg v 56 n 64 Aug 10 1932 p 630–2. Removal of oil, gasoline, and benzol residues from condensate with activated carbon; three systems in general use, namely, mechanical, chemical, and electrolytic.

STEAM ENGINES

UNIFLOW. Der Einfluss der Deckelheizung bei der Gleichstrom-Dampfmaschine, M. Rothemund. Zeit des Bayerischen Revisions-Vereins v 36 n 16 Aug 31 1932 p 186–7. Influence of cylinder-cover jacketing in uniflow steam engine; investigators show that by this form of heating, temperatures of cylinder surfaces and of first guide-face parts are increased, resulting in decrease in heat exchange and economic improvement of engine.

MARINE. Neuere Kolbendampfmaschinen, C. Commentz and Schmedding. Brennstoff und Waermewirtschaft v 14 n 7 July 1932 p 117–9. Modern marine reciprocating steam engines; valve gears; compound engines; advantage of uniflow engines; Lentz standard engines and other outstanding examples of recent design.

STEAM POWER PLANTS

ASH HANDLING. Neue Foerdermittel zur Entaschung von Dampfkesseln, F. Riedig. Feuerungstechnik v 20 n 8 Aug 15 1932 p 123–5. New ash-removal equipment for boilers; mechanical equipment; gravity conveyors; shaking conveyors with electromagnetic drive; conveyors with and without pump drive; hydraulic equipment; ash removal by scavenging and by hydraulic drive; pneumatic and portable equipment.

HEAT INSULATION. Plastic Steam Insulations, J. S. Gander. Mech World v 92 n 2375 July 8 1932 p 29–30. Plasticity in insulating material is obtained by using binding material; it is important that only those binding materials with good heat-resisting value should be used; with exception of state of vacuum, dry and still air is best insulation.

POWER AND PROCESS. Some Recent Installations Producing Power From Processes Steam. Sulzer Tech Rev n 3 1932 p 14–18. Installations made by Sulzer Bros.; back-pressure steam engine of 300 bhp in starch factory; 250 and 400 bhp back-pressure engines, admission pressure 170 lb/sq in. steam temperature 750 F installed in paper mill.

STEAM TURBINES

BACK - PRESSURE. Back - Pressure Turbines Give High Thermal Efficiencies, M. F. Knoy. Power v 76 n 3 Sept 1932 p 148. Advantages of back-pressure turbine operation under proper conditions; characteristics of specific plant; heat-entropy diagram showing adiabatic and actual expansion of steam in turbine.

BLADES. Machining Operations on Turbine Blade of Unusual Design, T. V. Greene. Machy (Lond.) v 40 n 1033 July 28 1932 p 517–21. Design of drop-forging die, milling jigs, and boring fixture used in manufacture of large turbine blade with curved root having teeth on both sides.

CONTROL. Apparatus for Steam Turbine Control, R. B. Smith. Elec J v 29 n 9 Sept 1932 p 439–41. Devices to indicate shaft eccentricity, blade and gland rubs, thermal expansion, and vibration, are added to those existing for denoting bearing temperature, steam characteristics, and load.

GERMANY. Bemerkenswerte Messergebnisse an 3000 tourigen Grossdampfturbinen Bauart Siemens-Roeder, K. Dietrich. Siemens-Zeit v 12 n 7 July 1932 p 238–41. Noteworthy results obtained with measurement 24,000/30,000-kw 3000-rpm steam turbines of Siemens-Roeder type shown in curves and tables.

MODERN BRITISH. Latest British Practice in Steam Turbine Design. Elec News v 41 n 16 Aug 15 1932 p 33. Description of 30,000-kw steam turbine with many interesting features, recently installed in Hackney municipal power station, London.

TESTING. System for Measurement of Steam With Flow Nozzles for Turbine Performance Tests, S. A. Moss and W. W. Johnson. Am Soc Mech Engrs—Advance Paper mtg Dec 5–9 1932 15 p. Particulars regarding system of steam-flow measurement by means of nozzle for performance tests of jet-condensing, non-condensing, or extraction turbines where condensate measurements are out of question; system as outlined is on laboratory basis in order to insure accuracy necessary when steam-turbine guarantees are involved.

STEEL

Die Bestimmung von Zeit—Dehngrenzen im Dauerstandversuch, E. Siebel and M. Ulrich. VDI Zeit v 76 n 27 July 2 1932 p 659–63. Methods of determining effects of time in testing various types of steel at low and high temperatures; evaluation of endurance tests with particular regard to procedure developed by Pomp and Dahmen; determination of creep by extrapolation.

Pomp-Enders Short-Time Creep Test, A. Pomp and W. Hoeger. Engineering v 134 n 3476 Aug 26 1932 p 232–4. Investigations of extent to which use can be made of accelerated test; same apparatus was employed as formerly used by Pomp and Enders with some modifications, study of extent to which stress corresponding to creep rates specified by Pomp and Enders could be regarded as limiting creep stress. Previously indexed from Mitteilungen aus dem Kaiser-Wilhelm-Institut fuer Eisenforschung zu Duesseldorf (Abh 199) v 14 n 4 1932.

HEAT TREATMENT. Verguetungsstaehle, E. Eichsald. Automobiltechnische Zeit v 35 n 15 Aug 10 1932 p 363–9. Physical properties and heat treatment of standardized and non-standardized steels, particularly alloy steels and their principal application in automobile construction.

SCALING. Behavior of Steel at Forging Temperatures With Respect to Scaling Losses, D. W. Murphy. Iron and Steel Engr v 9 n 6 June 1932 p 260–6. Investigation of effect of atmosphere and temperature with data on chemical composition of steels; estimates of scaling losses in industry for 1929 and 1931; oxidation equilibria; effect of small amounts of sulphur dioxide. Before Assn. Iron and Steel Elec. Engrs.

SPECIFICATIONS. Properties and Selection of Automotive Steels, T. H. Wickenden. Soc Automotive Engrs J v 30 n 6 June 1932 p 260–4. Tests on identical samples from several heats of two alloy steels; results coordinated in probability curves developed with aid of frequency charts; effect of nickel on impact properties of gear steels; British recommendations for steels for automobiles, proposed for standardization.

TEMPERATURE EFFECT. Modulus of Elasticity of Steel at High Temperatures, E. Honegger. Brown Boveri Rev v 19 n 5 July–Aug 1932 p 143–7. Tests have shown that at high temperatures modulus of elasticity is smaller the longer the time for which the load is applied; dependence of modulus of elasticity on time makes it necessary to take into account variation of loading with time.

STOKERS

IMPROVEMENTS IN. Les progrès récents dans les chauffages par grilles, Loutz. Pratique des Industries Mecaniques v 15 n 5 Aug 1932 p 165–74. Recent progress in traveling grate and stoker firing; comparison of types; advantages and disadvantages; dimensions; combustion rates; etc.

STRENGTH OF MATERIALS

SURFACE CONDITIONS, EFFECT OF. Strength of Materials as Affected by Discontinuities and Surface Conditions, F. C. Lea. Soc Glass Technology—J v 16 n 62 June 1932 p 182–205 (discussion) 205–9. Experiments to determine effect of discontinuities and surface conditions of metals on behavior of materials when subjected to cycles of repeated stress; plasticity and discontinuities; experiments on effect of grooves, etc. effect of surface conditions produced by heat treatment of steels; effect of corrosion on failure under repeated stresses; impact tests; static and dynamic.

TENSOMETERS

HOUNSFIELD. Hounsfield Tensometer. Automobile Engr v 22 n 294 June 1932 p 282–4. Design and operating principles of instrument weighing 29 lb and capable of testing materials with tensile strengths up to 100 tons per sq in., made by Birmingham Tool and Gauge Co.; typical tensile and notched-bar test curves. See also Engineering Index 1931 p 1447.

TURBO-GENERATORS

COOLING. Developments in Cooling of Parsons' Turbo-Alternators. Engineer v 154 n 3996 Aug 12 1932 p 165. Cooling equipment using grilled tubes at Dunston power station; two main air circulating fans are provided on each machine, each of sufficient capacity to enable alternator to carry continuous load of 40,000 kw with other fan out of service; together with duplicate air coolers, fans are housed within foundation block and coolers can easily be withdrawn for inspection.

WELDING

ARC-RESEARCH IN. Researches in Arc Welding, G. E. Doan and J. L. Myer. Elec Eng v 51 n 9 Sept 1932 p 624–7. Research in field reviewed briefly; laboratory tests have demonstrated impossibility to strike arc with 120 v between pure iron electrodes in atmosphere of pure argon, observation that may require modification of basic conceptions of nature of electric arc discharge.

BOILERS. See *Boilers*, Welding.

MACHINE. Machine Welding—Problems in Design and Operations, J. L. Anderson. Am Welding Soc—J v 11 n 6 June 1932 p 7–9. Shape and properties of material and quality of welds; suggestions for opercoming major difficulties in machine welding operations.

OXYACETYLENE. New Process for Making Welded Joints. H. S. George. Am Welding Soc—J v 11 n 7 July 1932 p 22–8. Self-fluxing process obviating melting of base metal by formation of carbonaceous film which enables fillet metal to unite with base metal; preparation and physical properties of welds; contrast in procedure of oxyacetylene fusion welding and new process.